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SURFACE DEALKALIZATION OF FINISHED GLASSWARE

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PART I

The role of the alkali in glasses is chiefly determined by the loose bonds with which the alkali ions are tied up with the silicate network. Its reactivity and its mobility in an electric field can be understood on this basis. In the absence of an electric field, alkali ions can migrate due to forces exerted by surface tension and if given an opportunity, can react with gases, vapors, fused salts or crystalline substances which are brought in contact with the glass surface.

In this paper the authors report a novel method for withdrawing alkali from the surface of finished glassware by means of heating the glass in contact with a clay slip or other refractory materials which are capable of reacting with alkali. Experiments are reported which illustrate the strong effect of this "dealkalization" by means of metakaolin on the chemical reactivity of the glass. A few new methods are discussed which permit differentiation between unaltered and dealkalized areas of a glass surface.

The effects of the dealkalization on the chemical resistivity, electrical conductivity, and strength are discussed.

Some Remarks on the Role of Alkali in Glasses

Experience of the past and modern concepts of the constitution of glass prove that the alkali ions are only weakly bound in the structure. Alkali in the form of soda ash or sulphate forms an important constituent of most glass batches because it has the unique power of breaking down the refractory sand and bringing it into solution. After having accomplished this task, the presence of alkali in the glass is less desirable. The alkali content is responsible for the high thermal expansion of soda-lime glasses which causes the ware to break when subjected to thermal shock. In contact with moisture, alkali goes into solution. This leads to the destruction of the glass surface. This is particularly true in all cases where the surface area is very large, for example, glass fibers. The superiority of silica glass insulators over soda-lime glass is due to the absence of alkali because only the latter is responsible for both the surface and volume conductivity. The vibrations of the loosely bound alkali ions in an electric field of high frequency transform electrical energy into heat and contribute to the power loss.

Many of the improvements of glass in the last few decades are based on a reduction or elimination of the alkali. The Pyrex brand glass and some types of fiber glass contain little or no alkali. The Vycor glass uses alkali to facilitate melting, but by an ingenious process practically all of it is withdrawn from the ware after having fulfilled its mission: breaking down the silica.

Some properties of glass such as the chemical durability and the electrical properties, could be improved if the alkali or part of it could be withdrawn from the surface layer of the finished ware. Bulk properties such as the coefficient of expansion would, of course, remain unaffected by this process. Before describing the experience of the past and our new way to dealkalize a glass surface we shall discuss the mobility of alkali ions and their migration through the glass structure at elevated temperatures.

Many characteristic properties of the alkali, for example, its effect on the electrical properties of glass or on the chemical resistivity, can be explained by the fact that the alkali ions, having only one positive charge, are the most loosely bound units of the glass structure. From a chemical point of view we might consider silicate glasses and some of the crystalline silicates, such as, zeolites or ultramarine, as huge anions of an isopoly or heteropoly acid. The negative charges of these macromolecules are counterbalanced by positive ions present in interstitial positions. If the positive ions have only one charge, like the alkalies, they remain relatively mobile. Divalent and trivalent cations are more strongly bound. The structure of glasses or minerals of this type is chiefly determined by the nature and structure of the anion which may consist either of an SiO_4^{4-} network (isopolyacid) or of a network of alternative SiO_4^{4-}, BO_4^{5-}, and AlO_4^{5-} groups (heteropolyacid). Glasses and minerals which have alkali ions in interstitial positions may give off cations or exchange them for similar ions when in contact with other substances. The base ex-

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change of zeolites and the silver staining of glass are typical examples.

The migration of alkali ions under the influence of an electric field has been studied repeatedly from both scientific and technical points of view. Our discussion shall be limited to:

(a) the migration of alkali ions from the interior of the glass to its surface under the influence of surface tension,

(b) the removal of alkali from the surface layer by its chemical reaction with gases, liquids and solids.

The following chapter concerns the establishment of a positive concentration gradient of alkali without the aid of external forces when a soda lime glass is heated to temperatures between about 250°C. and its softening range. Due to the surface tension, the Na_2O content of the glass surface becomes greater than that of the bulk of the glass.

If the glass surface is brought into contact with reagents which are able to combine with the alkali, a negative concentration gradient is established. A variety of compounds, i.e., gases, liquids, and solids, can be used for this purpose.

Migration of Alkali to the Surface

In rounding sharp edges of tumblers or glass tubes by heating them, the glassmaker takes advantage of a force called "surface tension." Surface tension exists wherever there are surfaces, i.e., where two phases adjoin. The surface tension tends to decrease the surface free energy of a system. It is responsible for a droplet of mercury retaining a nearly spherical shape in spite of the forces of gravity. In the case of mercury, a homogeneous one-component system, surface tension can decrease the surface free energy only by decreasing the area of the interface, mercury-air. The definition of surface tension is based on this property. Its unit is defined as either the amount of work necessary in a system to increase its surface by one cm^2 or by the force with which a surface tries to contract.

In multi-component systems the surface-free energy can be decreased not only by surface contraction but also by rearrangement of the molecules; that is, the migration of the constituent with the lowest surface tension into the surface layer. It is well known that certain fatty acids and higher alcohols, such as amyl alcohol, belong to the "capillary active" substances which lower the surface tension of water and consequently concentrate in the surface layer. An instrument has been developed by MacBain and Humphreys[1] which measures changes in the surface composition of a liquid. This "surface microtome" has a blade which is placed on rails running along a trough filled with the solution to be examined. The blade can be dipped into the liquid to any desired depth and then the top layer can be skimmed off by moving the blade at high speed over the surface. The skimmed off part of the liquid is caught and can be analyzed.

The theoretical basis for this migration was given by J. W. Gibbs[2] who was the first to derive from thermodynamic principles the relationship between the effect which a dissolved substance has on the surface tension of a liquid and its concentration in the surface layer. Gibbs derived the following equation:

$$U = \frac{c}{RT} \cdot \frac{d\sigma}{dc}$$

where U = excess of substance in surface layer
c = its concentration in the bulk of the liquid
σ = surface tension
R = gas constant
T = absolute temperature

This equation reveals that a substance reducing the surface tension of a liquid concentrates in the surface.

In aqueous solutions the diffusion of the capillary active molecules into the surface layer requires not more than a fraction of a second. In highly viscous media, such as glasses in or below the softening range, diffusion processes are much slower and consequently such a system can have surface tension values varying between two extremes. The higher value corresponds to the bulk of the mixture and is obtained by dynamic methods. The lowest value corresponds to the surface tension after thermodynamic equilibrium (migration and orientation of the capillary active substance in the surface) has been reached.

G. Keppeler[3] suggested that with glasses a distinction should be made between dynamic and static surface tension values. He pointed out that most glass forming operations do not allow sufficient time for reaching the lower equilibrium value. In silicate glasses the alkali migrates to the surface because it decreases their surface tension.

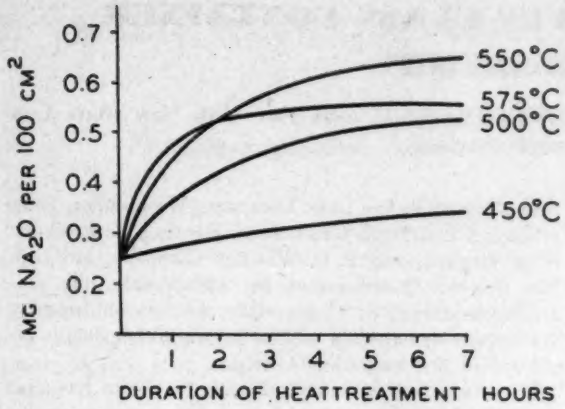
The lowering of the surface tension of glass by alkali oxides has first been observed by Lecrenier and Gilard[4]. Recently K. C. Lyon[5] presented a critical discussion of the literature on this subject and derived factors for the calculation of the surface tensions of glasses from their compositions at temperatures of 1200° and 1400°C. The effect of 1% oxide on the surface tension of glasses in which the ratio SiO_2:Na_2O exceeds 3.25 is given in the following table:

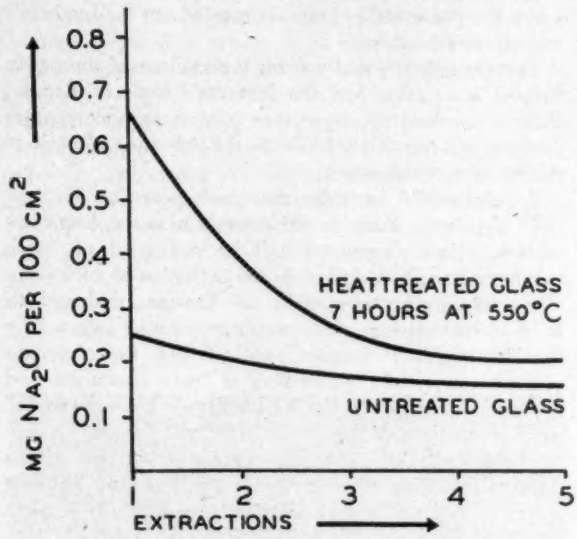
TABLE I

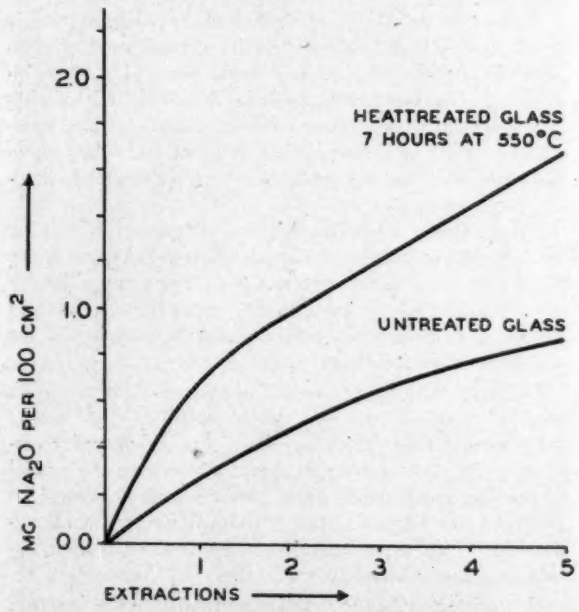
Oxide	Effect on Surface Tension in Dynes/cm	
	1200°C.	1400°C.
SiO_2	3.25	3.24
Al_2O_3	5.98	5.85
B_2O_3	0.23	−0.23
CaO	4.92	4.92
MgO	5.77	5.49
BaO	(3.7)	(3.8)
Na_2O	1.27	1.12
K_2O	(0.0)	(−0.75)

The values for BaO and K_2O give only the order of magnitude.

Table I shows that of the basic oxides the alkali ions have the strongest effect upon the surface tension. The theoretical reason for this is, that their bonds are the ones most easily satisfied even when brought into the surface layer where the coordination must necessarily remain incomplete. The same principle applies to the acidic oxides, where B_2O_3 has the lowest factor because it rearranges from BO_4^{-5} to BO_3^{-3} groups without major energy changes. Alkali migration becomes pos-







Top to Bottom: 1. Influence of time and temperature upon the alkalinity of the glass surface. 2. Alkali withdrawn from the glass surface by successive extractions. 3. Summation of alkali withdrawn from the glass surface in successive extraction.

sible even below the softening range because alkali ions are the most mobile constituents in the glass structure.

In glassware with pronounced surface development, such as with glass fibers, the alkali has to migrate through a layer which is only a few molecules thick. In this case depletion of alkali can be observed at slightly elevated temperatures, maybe even at room temperature. According to D. C. Simpson[6], the alkali migrating to the surface not only leads to the destruction of the glass fiber, but also interferes seriously with the wetting by lubricating oils. He found that this effect is noticeable with fibers having a total alkali content of more than 2—3%, and it becomes particularly disturbing if the glass has been exposed to temperature cycles. Simpson suggests several remedies, among them the application of acidic chemicals which neutralize the Na_2O. Normally the diffusion of alkali becomes evident only during heating processes, such as striking and annealing.

The migration of alkali into the outer surface layer might very well explain a phenomenon which has been observed in the Physical Laboratory of the University of Bristol. Pyrex glass which was used as an insulator was found to lose permanently its valuable insulating property after it had been baked out in a vacuum. The baking process which served to remove adsorbed gases aided the migration of alkali ions to the glass surface. J. H. Mitchell and H. H. Wills, who made a study of this behavior found that after the sample had been washed with HF, its insulating power had been completely restored. Carefully planned experiments were necessary to detect this alkali migration and to explain why annealing sometimes decreased the alkalinity of the glass surface when an increase was expected from the influence of surface tension. There are two factors in addition to surface tension which determine the net result:

(a) Structural changes of the glass during annealing (compacting) strengthen the bonds between the alkali ions and the anionic network.

(b) Alkali is removed from the surface of a glass by volatilization and by its reaction with furnace gases, especially sulphur dioxide.

Keppeler[8] was the first to point out that in respect to the influence of heat treatment on the alkalinity of glass a sharp distinction should be made between the chemical resistivity of the surface of the glass and that of the bulk. Today it is well understood that annealing not only removed mechanical stress, but that it also changes the constitution of a glass. Whether we express the constitutional changes in terms of dissociation-association equilibria or in terms of average interatomic distances and coordination numbers, it is evident that annealing strengthens the forces which hold the alkali ions in the glass. We have direct proof for this assumption: the chemical resistivity of a glass, expressed as the solubility of alkali, is a function of the heat treatment. If we determine the chemical resistivity of the bulk of the glass, by using a powder method the chilled glasses show a distinctly lower resistivity than the same glasses after annealing. There are other indications of the strengthening of the alkali bonds during annealing. For example, the electric conductivity, which is based on the

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TOLEDO COURT APPROVES GLASS CONTAINER INSTITUTE SET-UP

Judge Kloeb hands down order permitting Defendant Companies to cooperate with New Glass Container Manufacturers' Institute.

On May 15th the United States District Court in Toledo, Judge Frank Kloeb presiding, entered an order permitting the four glass container manufacturers who were defendants in the recent anti-monopoly trials, to cooperate within certain limits with the newly formed Glass Container Manufacturers' Institute.

This very desirable decree allowing the so-called defendant glass companies, namely Owens-Illinois, Hazel-Atlas, Ball Brothers and Thatcher to cooperate with the Standing Committees of the Institute, brings to fruition the work of the Committee appointed by the non-defendant manufacturers to create an organization which could function effectively for the glass container industry as a whole and in the interests of the public good. Members of this Committee who were ably assisted in their work by Fred E. Fuller, Toledo, Ohio, General Counsel for the Institute, are George F. Lang, R. R. Underwood, Lewis F. Gayner, Francis H. May, John D. Rau and Robert L. Warren.

Regular membership in the Institute is open to all non-defendant glass container manufacturers and manufacturers of closures as well as suppliers. The defendant glass manufacturers who have been granted cooperation privileges have the status of "non-member" companies. The non-member manufacturers have no voting power or control in the administrative affairs of the Institute but will be represented in the activities of the nine Standing Committees by one of their own employees technically skilled in the particular field of each Committee.

There are ten provisions enumerated in the Articles of Incorporation of the Institute. These include a brief outline of the purpose of the organization; the names of the temporary Trustees of the Corporation which are the same as the Committee mentioned in the foregoing, including the Institute counsel Fred E. Fuller; Article 5 lists the initial membership as follows: Anchor Hocking Glass Corporation, Lancaster, Ohio; Brockway Glass Company, Brockway, Pennsylvania; Buck Glass Company, Baltimore, Maryland; Carr-Lowrey Glass Company, Baltimore, Maryland; Chattanooga Glass Company, Chattanooga, Tennessee; Diamond Glass Company, Royersford, Pennsylvania; Dominion Glass Company, Ltd., Montreal, P. Q. Canada; Fairmont Glass Works, Inc., Indianapolis, Indiana; Florida Glass Manufacturing Company, Jacksonville, Florida; Foster-Forbes Glass Company, Marion, Indiana; Gayner Glass Works, Salem, New Jersey; Knox Glass Associates, Inc., Knox, Pennsylvania; Lamb Glass Company, Mt. Vernon, Ohio; Latchford-Marble Glass Company, Los Angeles, California; Laurens Glass Company, Laurens, South Carolina; Liberty Glass Company, Sapulpa, Oklahoma; Maryland Glass Corporation; Baltimore, Maryland; Maywood Glass Company, Los Angeles, California; Northwestern Glass Company, Seattle, Washington; Obear-Nester Glass Company, East St. Louis, Illinois; Pierce Glass Company, Port Allegany, Pennsylvania; Swindell Brothers, Inc., Baltimore, Maryland; Tygart Valley Glass Company, Washington, Pennsylvania; Universal Glass Products Co., Parkersburg, West Virginia, and T. C. Wheaton Company, Millville, New Jersey. Qualifications for membership, the non-profit character of the Corporation, the non-compensation for services or expenses of Trustees and other details are covered in the remaining Articles.

From a functional standpoint the Institute has nine standing Committees, the channels of cooperation between the non-member glass companies and the Institute's regular membership.

The Committees really form the nucleus of the newly formed association and the Institute's Code of Regulations, comprised of seventy-one provisions, incorporates detailed information relative to the activities of each of the Standing Committees.

Regulation 36 provides that each year the Trustees shall appoint at their annual meeting nine standing committees. Each committee will be composed of "such number of persons skilled in the activities of such committee as may be selected by the Trustees, and each to have as its chairman such person as may be selected by the Trustees." It is also provided that the *chairman* and a *majority* of the members of "each committee and sub-committee thereof shall be officers or employees of *regular members* of the Institute.

Space limitations prohibit publication in full of the detailed functions of each Committee, but the following enumerates the nine groups with brief outlines of their activities.

Committee on Market Research and Promotion. This Committee will devote itself to the advancement of competitive interests of the glass container and closure industries. Its work will include the study of existing and potential uses of glass containers and closures, comparative costs and distribution in glass and other materials and other factors pertaining to new product packaging requirements, etc.

Traffic Committee will deal with all matters pertaining to carriers and transportation on an industry-wide basis. Among its aims this Committee will have as an objective the obtaining of parity shipping rates for products in glass and competing containers; and the securing of the lowest possible freight rates.

Committee on Government-Industry Relations. With respect to this Committee the regulations state that it "shall coordinate the resources of the industry for service to the government and the public during the period of the war and thereafter and provide liaison between the Institute and Federal, State and local governmental authorities." To expedite its work the Institute will maintain an office in Washington, D. C.

Committee on Labor Relations. It will be the function of this Committee to assist the industry through research and through all other proper means to improve employer-employee relationship.

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BASIC REGENERATORS AND SUPERSTRUCTURES FOR GLASS TANKS

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The past twelve years have witnessed a growing and widespread acceptance of unburned basic brick as the answer to several vexing problems that habitually plague the glass industry. The rapid progress of the past five years has been due to a program of periodic inspection and analysis of observed results. Applications in checker service during 1940 and 1941 have been previously reported by Grigsby,[1] and Fig. 5 of that article illustrates an extremely gratifying early basic checker installation. For example, the brand is visible on the brick next to the wall in the fifth course, as compared with the badly melted condition of the fireclay brick in the center of the twelfth course.

Shortly afterward, increased production and higher furnace temperatures created new problems. Fig. 1 illustrates an aggravated condition which may occur when the operating temperature nearly coincides with the eutectic for the refractories and batch dust. In this particular case, the refractories in question were sillimanite, which would not be seriously affected by heat alone. However, the batch carry-over caused a sufficient slagging to produce a thick doughy mixture which solidified as soon as the checker passages became blocked. The substitution of basic brick, which does not react with the batch dust, affords no sticky surfaces for the adherence of the dust, so that the latter passes harmlessly through to the flues.

Fig. 1

Fig. 2

Fig. 2 also illustrates an aggravated condition, but of a slightly different type. In this case the slag from the uptake walls and uptake cap was fairly fluid, and did not freeze until it had reached a point about six courses down from the top of the checkers. In this position, a sufficient amount of heat had been removed from the exit gases to permit the slag to solidify and block off the checker openings. Additional quantities of slag filled the blocked off portion of the checker openings in the upper courses, and then worked sidewise until the upper portion was completely ineffective. In spite of the rough handling which knocked off the top course in the process of removal of this section of checkers, the remaining brick were practically unaffected. The corners were still relatively sharp and the brands on a number of the brick were readily discernible. The entire mass was held together by the solidified slag, although the slag had a tendency to pull away from the brick surfaces as a result of shrinkage due to cooling. The condition portrayed by this illustration was so completely corrected by a set of basic uptakes that an occasional puff of 40 lb. air through a ½" line restores the original brick surface.

From the foregoing illustrations, we can readily see that two distinct problems are involved in satisfactory

[1] "Ritex Basic Brick in Glass Tank Checkers," by Chester E. Grigsby, THE GLASS INDUSTRY, April, 1941.

Fig. 4

regenerator service. In other words, no matter how good the checkers are, they can readily be rendered ineffective by a wet superstructure. Fig 3 illustrates a regenerator crown which is good for five or six years, but contributed to a bad checker condition. The curved waffle iron appearance affords conclusive evidence of slag attack, and almost invariably slag freezes at some point in the checkers, causing plugging. Regardless of the length of the life of a regenerator crown, it is well to remember that the slag consists of 80 per cent to 90 per cent batch dust, with the balance made up of the loss in the brickwork. Thus, a 2″ loss in the brickwork from the back half of a regenerator crown and superstructure may amount to only sixty cubic feet, but it is the principal factor in the production of about 300 cubic feet of slag in the checkers. Whether this slag occurs in the upper or lower portions of the regenerator is of academic interest only. Its removal occasions an expenditure of arduous toil with sledges and concrete busters. Working conditions which are bad enough on a regular rebuild, become almost intolerable on a hot repair.

Most furnace operators will readily subscribe to the statement that elimination of slag from the regenerators is a desirable goal. The means of accomplishing this end, however, have varied considerably. Substantially the entire range of silica-alumina refractories has been tested, with an average time interval requirement of two years for each test. Is it any wonder that some operators have considered the search for a non-slagging brick to be fruitless, and that they have gone back to the more inexpensive refractories, resigned to the burden of recurrent hot repairs?

Fig. 4 illustrates a test panel of unburned chrome brick, four courses high, surrounded by super-duty brick. The two upper courses of basic brick lost less than 1″ of their original length, while the original 9″ of super-duty brick have been cut away to 3″. The result has been a cantilever action on the lower two courses, followed by spalling, until a corbelled support has been approximated. A similar test was sufficiently promising to lead to a full scale trial installation.

The first installation of unburned chrome uptakes was placed in service early in 1942. It consisted of walls only, surmounted by a super-duty suspended cap. This installation, after fifteen months, is shown in Fig. 5. Examination of the lower right-hand corner discloses the manner in which the best grades of super-duty clay brick are cut away by the slagging action of the carry-over. The arches have been washed away by slag action until the surfaces are approximately 45° with the vertical. As a matter of fact, it was unsafe to leave these arches in place for a second campaign, in spite of the fact that the basic brick in the uptakes retained substantially their original dimensions.

The second installation of unburned chrome brick in uptakes went through a campaign of 21 months, at the end of which time the super-duty supporting arches needed replacement, having been cut away in a manner similar to that already described. The workmen salvaged 25 per cent of the chrome brick without breakage and used them in the upper vertical walls of the regenerator to a depth of 2′ below the top of the checkers. The maximum loss of basic wall thickness did not exceed ½″ in the locations of most severe service.

Following the latter experience, the use of unburned basic brick was extended to the regenerator crown, port

Fig. 3

Fig. 5.

sidewalls and port crown. Unburned magnesite checkers, in connection with this installation, show a complete absence of slag. The horizontal surfaces on the top course merely exhibit a slightly dusty appearance, as though a flour sifter had been passed quickly over them. First quality firebrick in the lower portions of the checkers, supporting twelve courses of unburned magnesite checkers, are heated only to a dull red color and are, therefore, below the eutectic for fireclay and batch dust.

The dry surfaces of basic brick present a characteristic appearance, similar to that of dry snow in the corner of a window sill when the temperature is around 0° F. This accumulation is readily removed, although such procedure is unnecessary. In one case two ports were cleaned in one and one-half hours, most of the time being spent in erecting a scaffolding. It has also been noted that chrome port sidewalls and crowns protect silica-alumina port floors, which remain dry, indicating that their usual wet appearance is caused by slagging of the walls.

Another interesting application of unburned chrome brick was the topping off of the division walls in the uptakes on one side of a producer gas fired furnace, with two courses of unburned brick, laid flat, as headers. At the end of the fifteen months' campaign, the top six courses of super-duty brick on one side had disappeared, while the basic brick are shown in

Fig. 6. The 6″ rule in the left-hand portion of the photograph indicates the absence of attack on the unburned chrome brick. The almost complete destruction of the super-duty brick caused a loss by spalling of approximately 1″ from the unsupported ends of the basic brick. On the other hand, the holes in the super-duty portion of the wall afford conclusive evidence of the combustion of gas in the up-takes, with a consequent waste of fuel and destruction of the refractories.

With additional experience in the application of unburned chrome brick to superstructure requirements, there developed a hope, and in some cases a strong belief, that the elimination of drip from this location would permit the use of cheaper refractories in checkers. This idea was soon proved erroneous when a set of basic checkers collapsed under the back ports after six weeks' service in a tank with complete basic superstructure, and were replaced with fireclay brick which lasted only ten weeks. Checker temperatures measured 2600° F., or 100° higher than the maximum recommended for basic brick in standard settings. The combination of continuous soaking heat, a severe batch dusting condition, and a 300° F. change in temperature every twenty minutes, called for further study of the problem. First of all, a basic brick was called for, to resist the attack of batch dust and condensation of volatile alkalies. A burned brick was unsuitable because these have been tested in checkers and have failed in twenty-four hours by spalling, even though the softening point is well above 3000° F.

The solution to this problem is the use of a basketweave setting which provides support for the entire length of each brick, as illustrated in Fig. 7. The brick in the foreground comprise a standard set transverse course, spaced by filler brick for supporting the first basketweave course which is shown in the background. 15″ x 2½″ brick with ¼″ spacing at each end provide 6½″ square openings, while 13½″ x 3″ brick with ¾″ spacing at each end provide 6″ square openings, which are the same as those obtained with 9″ x 2½″ and 9″ x 3″ brick, respectively, in standard settings. Each brick is thus given adequate support, the crushing strength is ample for the service required, and the brick cannot collapse.

Furnace operators naturally are skeptical of this in-

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Fig. 6

GOVERNMENT CHARGES FLAT GLASS INDUSTRY WITH MONOPOLY

In a release dated May 23 the Department of Justice announced the filing in the U. S. District Court at Toledo, Ohio, of a civil suit charging the Libbey-Owens-Ford Glass Company, the Pittsburgh Plate Glass Company, seven other flat glass manufacturers, and the National Glass Distributors Association with monopolistic activities in violation of the Sherman Anti-trust Act.

In addition to the glass corporations which were named in the Government's action, sixteen of their principal officers were included.

The following is a verbatim account of the major portion of the Justice Department's release.

The "flat glass" involved includes plate, safety, window, tempered and sheet glass.

The Attorney General said the complaint charges that in 1928 Pittsburgh Glass and Libbey-Owens-Ford embarked upon a program to secure a monopoly of the flat glass business in the United States. It is charged that this program was effected by a series of mergers and consolidations; by the purchase and subsequent dismantling of competing plants; by adoption of joint trade practices, including division of fields, territories and customers, limitation of production, and price fixing at all levels of distribution. In addition, the complaint alleges that competition with foreign manufacturers was eliminated through agreements by which the latter agreed not to export flat glass to the United States in return for increased financial support and exclusive rights abroad to the defendants' patents.

Named as defendants in the civil suit were:

Libbey-Owens-Ford Glass Company, Toledo, and John D. Biggers, president; D. H. Goodwillie, executive vice president; G. P. MacNichol, Jr., vice president in charge of sales; H. H. Baker, vice president and secretary, all of Toledo. Pittsburgh Plate Glass Company, Pittsburgh, and Clarence M. Brown, chairman of the board; H. B. Higgins, president; R. B. Tucker, manager of glass sales and warehouses, all of Pittsburgh. American Window Glass Company, Pittsburgh, and William L. Monro, president; A. E. Braun, first vice president, both of Pittsburgh. Fourco Glass Company, Clarksburg, W. Va., and Eugene Rolland, president; W. M. B. Sine, in charge of sales, both of Clarksburg. Franklin Glass Corporation, Butler, Pa., and Robert Ingouf, treasurer and vice-chairman of the board; Eugene Gentil, chairman of the board, both of New York City. Rolland Glass Company, Clarksburg, W. Va. Corning Glass Works, Corning, N. Y., and Amory Houghton, Corning, chairman of the board. American Securit Company, Corning, N. Y., a patent holding company. Blue Ridge Glass Corporation, Kingsport, Tenn., and William H. Curtiss, Corning, N. Y., president. National Glass Distributors Association, Chicago, and North Storms, Chicago, secretary.

Assistant Attorney General Wendell Berge, in charge of the Antitrust Division, stated that the result of the program of Pittsburgh Plate and Libbey-Owens-Ford has been complete elimination of competition in the flat glass industry in the United States. He said that the industry in this country is now divided as follows:

Plate glass—Pittsburgh Plate 48%, Libbey-Owens-Ford 48%, Franklin 4%. Safety glass—Pittsburgh Plate 49%, Libbey-Owens-Ford 49%, American 2%. Window glass—Pittsburgh Plate 30%, Libbey-Owens-Ford 30%, American 20%, Fourco 20%.

As of 1928, he said, there were in the United States only nine companies making plate glass, six companies making safety glass, and nineteen companies making window glass. Imports were 12% of domestic consumption in plate glass, 10% in window glass, and negligible in safety glass.

The Conspiracy

The complaint charges that:

(1) Competition was eliminated in the plate glass field by merger, outright purchase of competing firms, institution of price wars, and agreements with automobile manufacturers to supply most of their requirements. In normal times the automobile industry consumes about 75% of the plate glass produced in the United States.

(2) Competition was eliminated in the safety glass field by the purchase of some competitors and by licensing patents owned by the remaining concerns on condition that such firms refrain from producing safety glass in the United States.

(3) Competition was eliminated in the window glass field when Pittsburgh and Libbey-Owens-Ford agreed to finance four other manufacturers who, in 1935, formed Fourco Glass Company in order to stifle competition. Fourco then became the exclusive selling agent of these companies, each of which owned Fourco stock in the same proportion their individual sales bore to the total sales of all four companies.

During 1935-38 Fourco, with the financial assistance of Pittsburgh and Libbey-Owens-Ford, purchased the remaining 16 independent window glass manufacturers and dismantled the plants. Thereafter Pittsburgh, Libbey-Owens-Ford, American and Fourco divided the window glass market among them—30% each to the first two, 20% each to the latter two.

(4) Competition between the five non-competing manufacturers of flat glass—Pittsburgh, Libbey-Owens-Ford, Franklin, American and Fourco—was eliminated by:

(a) Allocating to each a fixed percentage of the business;

(b) Dividing sales territories among themselves;

(c) Establishing patent pools and cross-licensing each other under patents held by each;

(d) Limiting production and fixing prices on all types, sizes and grades of flat glass;

(e) Fixing resale prices for their jobbers and distributors and limiting the amount each jobber may buy. It is charged, in this connection, that the defendants discriminate among purchasers of flat glass by arbitrarily classifying customers and by selling at different prices to the same type of customer.

(5) Foreign competition was eliminated by granting exclusive licenses to foreign manufacturers, under present and future patents and know-how, on condition that the

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SUMMARIES OF TWO A.C.S. PAPERS

As reported in last month's issue of THE GLASS INDUSTRY, due to the cancellation of the Annual Meeting of the American Ceramic Society, many of the papers scheduled for presentation were delayed. However, the Society has arranged for the release of proofs of the various papers for the purpose of summarization as they are put into type.

Thus far proofs of two complete papers have been received by THE GLASS INDUSTRY: "Microstrength of Glass," by H. E. Powell and W. F. Preston, Preston Laboratories, Butler, Pa., and "Continuous Tank for Hand-Blown Glass," by F. G. Schwalbe, Toledo Engineering Co., Toledo, Ohio.

Summaries of these two papers follow and others will appear in these columns, as complete proofs are released by the Society.

Microstrength of Glass. *By H. E. Powell and F. W. Preston, Preston Laboratories.*

It is shown experimentally that if a minute area of a large piece of glass is tested for tensile strength, the stress supported is comparable with that of fine glass fibers, and is some fifty or one hundred times the "strength" of the large piece tested in any of the ordinary ways. The experiment consists in pressing a small steel ball upon the glass surface, and so stressing, in tension, a minute annular zone around the circle of contact. Various types and compositions of glass were tested by this method. Determinations were also made of, 1—the microstrength as function of area stressed and, 2—the microstrength as function of ball diameter and surface treatment.

It was concluded that: The microstrengths obtained by the pressure-cone method on large specimens are strictly comparable in magnitude with those normally obtained on fibers. This conclusion seems to establish the fact that the strength of fibers is largely due to their small size and not so much to orientation.

Continuous Tank for Hand-Blown Glass. *By F. G. Schwalbe, Toledo Engineering Company.*

The quality of glass obtained from a continuous glass-melting furnace is dependent on raw materials, fuels, furnace design and operation, and skill in the art of gathering and manipulating molten glass. The present paper deals with information on furnace design and construction and its effect on the ultimate quality of the glass that can be produced when proper fuels, raw materials and labor are employed.

The quantity of glass required determines the melting area of the furnace and this in turn determines whether an end port or side port furnace should be selected. The melting area is determined by the kind of glass to be melted. In general, melting areas are as follows: soda-lime crystal, lead glass, or colored soda-lime crystal are melted on 8-12 sq. ft. per ton; borosilicate for pressed ware on 11-15 sq. ft. per ton, and borosilicate for thin blown ware on 16-21 sq. ft. per ton.

Knowing the tonnage to be produced and using the above values, the area of the melting end can be determined. In the case of areas greater than 300 sq. ft. side port design is selected while end port designs are selected for areas up to 300 sq. ft. If side port designs are used for furnaces with a melting area of less than 300 sq. ft. the holding heat per sq. ft. would be far in excess of that indicated for the end port design.

The depth of the furnace is governed by the type of glass and may be as follows: soda-lime crystal, 36 in. depth; lead crystal, 30-36 in. depth; borosilicate for ovenware, 36 in. depth; color soda-lime, variable. The design of throats is fairly well standardized and the conventional straight-through design is used in most cases. Drop or submarine throats may be used in soda-lime crystal furnaces. Regenerative type furnaces are most used.

Temperature distribution within a furnace should have careful study, and the furnace design should be such that the required gradient can be established and maintained. Optical readings taken on the glass on both sides of the bridge wall in general are:

	M.E.	*W.E.*
Crystal soda-lime	2500°F.	2350°F.
Lead crystal	2550°F.	2300°F.
Borosilicate	2850°F.	2650°F.

The design of the shadow wall is important, and must be such that it will permit only the proper amount of heat to radiate and waste gases to circulate through the working end of the furnace. The furnace pressure should be adjusted to give maximum thermal efficiency consistent with the production of good glass and not to control the working-end temperature.

Gathering openings: When working under a plus furnace pressure a water-cooled shield may be used. To permit various temperatures of glass to be gathered a full ring of any desired depth may be easily installed and replaced. The ring may be anchored to the flux wall.

Under instrumentation the use of fuel meters, air meters, temperature measuring instruments, pressure instruments, glass level gages and automatic batch feeders were discussed.

In the discussion on fuels it was stated that it is simple to obtain flame coverage of the melting end with producer gas because of its low heating value. Natural gas is ideal because of its cleanliness and ease of handling. Application can be by introduction to burners firing at a pressure ranging from 10 to 24 oz. Fuel oil can be used successfully on either end port or side port furnace. Application on end port furnaces should be above and below the ports. In the case of side port furnaces below the port application of fuel is satisfactory. As second choice, firing of the fuel above the ports will give excellent results.

PARFITT ELECTED VICE PRESIDENT IN CHARGE OF SALES FOR THATCHER

Thatcher Manufacturing Company recently announced the election of David R. Parfitt as Vice President in Charge of Sales for the company. Mr. Parfitt succeeds Mr. George Dusterdieck, who resigned to become Branch Manager of the Rochester office of the company.

Mr. Parfitt started with Thatcher in 1923. A year later he became Assistant Sales Manager and then Sales Manager of the Milk Container Division in 1943.

Mr. Parfitt has announced the following promotions in the Sales Division: Frank W. Edson, Sales Manager, General Line Division; William W. Springfield, Sales Manager, Milk Bottle Division; Kenneth H. Hay, Sales Manager, Beer and Beverage Division, and John B. Miller, Assistant to the Vice President in Charge of Sales.

● Ball Brothers Company of Muncie, Indiana, have announced that Alvin M. Owsley, a director of the concern, has been appointed vice-president of the Ball Brothers Glass Company of Texas. Mr. Owsley is a native of Dallas and following his retirement from U. S. Diplomatic Service in 1939 he joined the Ball Company. Mrs. Owsley is the former Lucy Ball, daughter of Mr. and Mrs. Frank C. Ball.

INVENTIONS AND INVENTORS

A Summary of Patents of Interest to the Glass Industry Issued During April

Furnaces

Wm. E. Grempler has patented a furnace system by means of which the hot gases from the melting chamber of a glass tank are directed through a recuperator and then to a boiler operated in conjunction with the glass furnace. The recuperator serves to preheat air for combustion. This is patent 2,370,656. From the point of view of specification writing it is interesting to note the first paragraph in which it is stated that the invention may be used by or for the Government without payment of royalty.

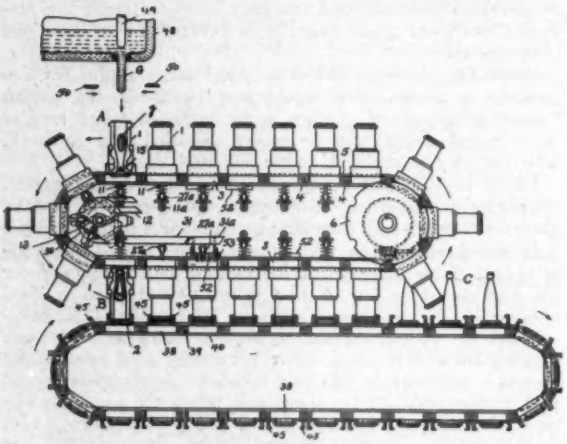

Fig. 1. Forter : 2,373,820 Container forming machine adapted to making ware of two or more sizes at the same time.

Feeding, Forming and Shaping

Fig. 1 from Samuel A. Forter's patent 2,373,820 shows improvements in the type of bottle forming machine described last year by Henry F. Teichmann in patent 2,357,702. The gobs drop into open two piece molds whose bases are linked together to form a continuous chain; the chain moving counter-clockwise brings the units into blowing position and into union with a similarly linked chain which provides plates 38 which shape the bottom of the bottle and support it when the two linkage systems part to free the finished ware. This machine has so high a rate of production that it became necessary to improvise improvements which would allow two or more types or sizes of ware to be produced simultaneously. These changes represent the Forter invention. The steps required were the orthodox ones of providing the several types of molds in the desired sequence and in controlling the size of gob accordingly. Beyond this, it was necessary to alter the length of the blowing cycle for the larger ware. To understand what was done it should be noted that the valves which release compressed air for blowing are controlled by the position of rollers 27a. When a mold is in the position of 38 (lower left) this roller is riding on rail 31 whose position is such as to hold the air valve in the open position. Blowing ceases when the roller comes to the end of this stationary rail. However, if it is desired to extend the blowing period so as to form a larger bottle, a rail extension 31a is swung into place, where it is held only so long as this size is being formed.

Russell G. Allen of Alton, Ill. (Owens-Illinois Glass Co.), received patent 2,372,642 (to accompany an earlier one 2,351,899) covering a glass blowing machine of the Owens type in which there are means for holding individual mold units out of movement so they may be repaired or replaced without stopping the machine.

A method of pressing lens blanks is described in patent 2,373,246 assigned to Pittsburgh Plate Glass Co. by Perry Johnston of Ford City, Pa.

Miscellaneous Processes

Patent 2,231,811 to J. T. Littleton and others of Corning Glass Works described tempering apparatus adapted to receive ware immediately after its formation, to heat such ware to an equalized temperature throughout its mass and then to successively pass the ware through a chilling bath, through a tunnel in which air blasts further cool the ware, and finally through a wash bath. This patent cited specific molten salts and salt mixtures suitable for use as heating baths and also taught the use of baths at lower temperatures for chilling or tempering ware which had previously been heated to a given temperature. Now John K. Jackson contributes 2,372,898 to the Corning group of tempering patents by describing improved apparatus. Basket-like supports for carrying such ware as tumblers are conveyed through the treating units, and during immersion in the heating and chilling baths, generally hold the ware in horizontal position. However, on leaving the first bath the holder is tilted so that the hot liquid will drain out rather than

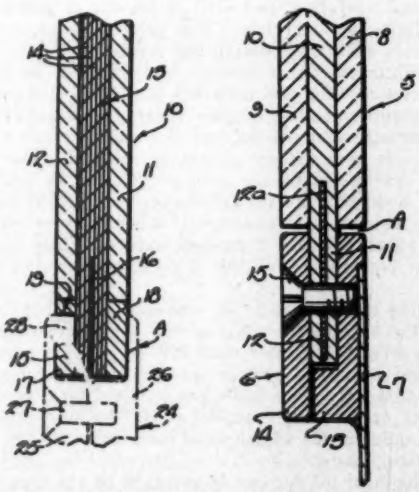

Fig. 2. Watkins. : 2,374,056 (left) and 2,374,057 Laminated glass structures with the plastic layer extending beyond the glass for anchoring.

be carried into the chilling tank. Means may be provided of tilting the ware as it enters both baths if the shape of the article requires it.

Another Corning Glass patent is 2,374,288 in which Ray A. Hinkley and John L. Miller describe apparatus for applying metal coatings to glass surfaces. In doing this by means of a gun which atomizes the metal and sprays it onto the glass it is necessary to provide a lehr in which the ware is brought to the proper receiving temperature, and it is essential that the coating be not too thick, or else it may spall. If it is a circular object which is to be sprayed it is easy enough to meet these requirements merely by rotating the ware in front of the spray. However, if it is non-circular in outline it will not pass the spray at a constant peripheral speed. This latest invention provides means which rotate such ware at varying speeds suited to their shapes and also shift the spray source so as to maintain it at a constant distance from the ware.

Methods of completing lamp assemblies which involve glass to electrode seals are described in 2,374,546 granted to Joseph P. Laico of Bell Telephone Laboratories, Inc., and 2,374,269 granted to an English group comprising R. L. Breadner, John W. Harris, and Chas. H. Simms assignors to General Electric Co. In the latter patent a lamp stem unit is spun so that centrifugal force will aid in flowing the softened glass around the electrodes.

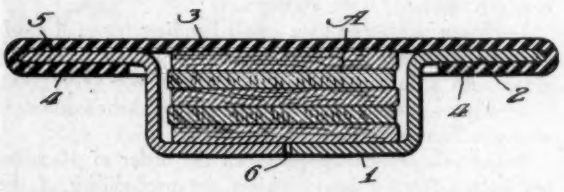

Fig. 3. Beasecker : Reissue 22,636 Wide lipped rubber cover for sealing the flanges of a die unit in which laminated glass is autoclaved.

Other late patents are 2,372,646 issued to Herbert A. Barnby and John Hohl, Owens-Illinois Glass Co., for a conveyor for moving bottles through an assembly station for the application of a closure, and 2,373,639 to Arthur F. Turner, Bausch & Lomb Optical Co., for means of volatilizing a metal film onto an optical surface.

Sheet and Plate Glass

A total of four patents were issued for means of preparing laminated sheet structures. Of the three which were assigned to Libbey-Owens-Ford Glass Co., two represented the inventions of George B. Watkins of Toledo. These were 2,374,056 and 2,374,057. Both are concerned with laminated glass in which the plastic interlayer is extended beyond the edges of the glass to serve as a flexible attaching flange. The two types of structures are indicated in Fig. 2. The right hand view from the second of the Watkins patents shows the extending plastic sheet 11 with a flexible strip of aluminum 12a projecting inwardly a short distance between the glass sheets. To destroy the bothersome reflecting surface of the metal, it may be sand blasted. The left hand view of Fig. 2 shows the somewhat more complicated structure of the

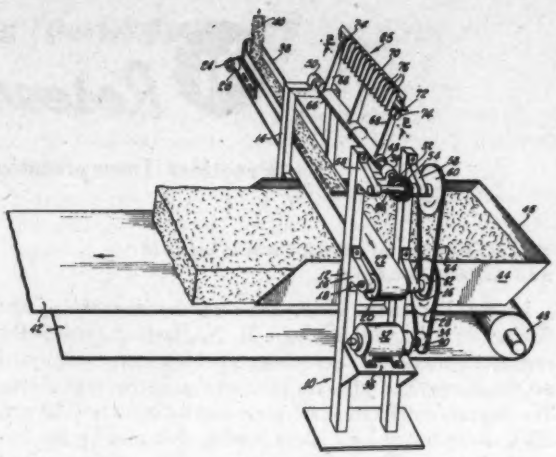

Fig. 4. Hawthorne : 2,373,183 Forming a blanket of fibrous nodules by sweeping them from a small conveyor into a hopper riding above a larger conveyor.

first Watkins patent. The relatively thick plastic interlayer again extends beyond the edges of glass, and again there is a metal reinforcing strip 16; however, in addition there is a plastic flange 18 having substantially the same thickness as the glass sheets, and channeled on one side at 19 to receive the mounting means.

The third patent of this Libbey-Owens-Ford group is 2,374,040 which was issued to Joseph D. Ryan of Toledo. It provides for a new type of flexible container to hold laminated assemblies while they are being permanently united in an autoclave by hydraulic pressure. This container is made of polyvinly alcohol material in place of rubber which is said to be more expensive and less resistant to penetration by the autoclave oils.

For carrying out the same operation R. L. Beasaecker of Grand Rapids uses the rubber housing of Fig. 3 but with an improvement which eliminates the necessity for damaging the rubber by using clamps on it. The U shaped steel member 2 supports the sheets which are to be bonded by autoclaving. The rubber member 3 is constructed with a fairly deep endless groove which is slipped over the edges of the steel work support. It is reported that when pressure is applied in the autoclave the effect is to form a tight seal automatically. This is Reissue patent 22,636.

Glass Wool and Fiber

Patents assigned to Owens-Corning Fiberglas Corp. include 2,373,077 and 2,373,078 granted to Dale Kleist of Newark, O. The first of these covers the use of a grooved block of graphite for grouping a multiplicity of glass fibers so as to form a strand or silver. Such a block is non-abrasive and is wear-resistant. Kleist so shapes the guide as to give it a supply reservoir for holding oil or other lubricant to be applied to the fibers. In his other patent the claims are directed to apparatus used in the bonding of a fibrous mat of glass wool, the equipment serving to hold the fibers together while curing the binder.

Apparatus for applying mats of glass fibers to battery plates in the manufacture of storage batteries is described

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GJ Research Digest

Practical Interpretations of Glass Technology

The Behavior of Glass Under Impact and Static Loading

In the February, 1944, issue of the *Journal of the Society of Glass Technology*, R. N. Haward reports the results of numerous experiments which were performed on the strength of glass in the form of beams and plates. The beams, cut from sheet glass approximately 0.28 cm. thick, were tested by a slow loading test and by the impact of a pendulum. The squares, also cut from sheet glass, were tested both by pressing a steel ball centrally against the square and also by the impact of a falling steel ball.

It was shown that in the case of slow impact when using objects much heavier than the glass, the energy required to break the glass is greater than that needed under static conditions. The difference can be explained if the known changes in the modulus of rupture of glass with time are taken into account. As the velocity of impact is increased, however, the energy required to shatter a glass plate generally diminishes markedly. This decrease in strength is ascribed to the operation of stresses, due to the weight of the glass, the initial value of which is given approximately by the relation $v\sqrt{E}p$.

When glass is broken by small balls at high velocities characteristic cone or "shell" fractures are produced, which appear to be an extension of the statically formed ring cracks along lines perpendicular to the maximum tension in the glass.

The co-efficients of variation of the measured quantities were given in a number of cases. Impact tests give a larger variation in the results than static tests since the former give estimates of the energy required to break and, hence, contain the term $(f\ (1 + v))^2$ where v is the co-efficient of variation of the stress required to applied than those required to fracture the glass. As this energy is increased further the laminated glass has a tendency to break up into a number of large pieces, that is, to be brittle. This property of brittleness is a variable one, and for any given impact there is a given probability of brittleness. The experiments show that the capacity of laminated glass to resist a blow of a given energy is markedly increased at velocities above 20 m.p.h.

Under bending, thermally-toughened glass behaves in a manner similar to sheet glass, except that the bending strength is approximately doubled. Under slow impact the strength of the material is also large, but as the incident velocity is increased above 20 m.p.h. there is a drastic reduction in strength. The various properties of toughened glass can be quantitatively explained on the assumption that it behaves like sheet glass with a constant compressive stress at the surface.

A clear understanding of the differences in behavior of toughened and laminated glass is essential to the correct application of these materials in practice. The conclusions reached by the author were:

1—When subjected to a small bending force, the differences in behavior between toughened and laminated glass with a fairly hard interlayer are not very great.

2—Under large bending stresses, toughened glass is stronger than laminated glass.

3—At low velocity impact (on the order of 10 miles per hour) from a heavy object the probability of the object breaking up the material and passing through is not very different for similar pieces of toughened and laminated glass.

4—At velocities greater than 20 m.p.h. the resistance of laminated glass to impact is much greater than that of toughened glass.

The Behavior of Laminated and Toughened Glass Under Static Bending and Impact at Different Velocities

The studies on glass breakage conducted by Haward included work on laminated and toughened glass and this phase of the work has been reported in the June, 1944, issue of the *Journal of the Society of Glass Technology*.

It was shown that the bending of laminated glass with hard cellulose interlayers is not very different from that of sheet glass, but when a soft vinal interlayer is used the apparent modulus of elasticity is reduced. This decrease is most marked with small pieces of glass, and tends to the value to be anticipated if the two pieces of glass were independently deformed.

When broken under impact just heavy enough to crack at least one of the glasses, laminated glass with a cellulose acetate interlayer again behaves in a manner similar to that of sheet glass. The interlayer resists splintering, however, and the assembly remains a coherent whole until much higher energies of impact are

The Variation of Apparent Porosity Through a Slip-Cast Sillimanite Tank-Block

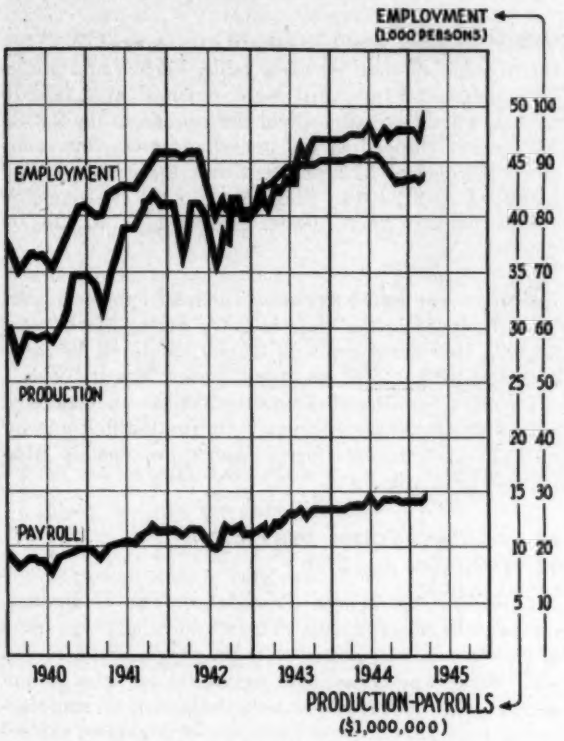
Boow and Walker (*Journal of the Society of Glass Technology*, June, 1944), have made determinations of the apparent porosity of forty-five representative specimens taken from different parts of a slip-cast sillimanite tank-block. The determinations were repeated after the samples had been subjected to each of three successive refiring treatments at 1500°C for four hours. The mean value for the whole block, as received, was 20.3%, but individual values varied from 18.9 to 21.4%. The highest values ranged, in general, around positions six to nine inches from the bottom of the block when cast. Thus, the mean porosity values at depths of one, three, six, nine and eleven inches were 19.8, 20.4, 20.5, 20.6 and 20.1% respectively. Prolonged firing gradually decreased the porosity of each specimen, the mean values for the whole block being 18.6, 17.9 and 17.6% after four, eight and twelve hours refiring at 1500° respectively.

(*Continued on page* 300)

CURRENT STATISTICAL POSITION OF GLASS

THE GLASS INDUSTRY'S INDEX

Monthly Trends Through March, 1945



Activity in the glass industry during March showed an increase over that reported for the month of February. As shown by the Production Index, production for March was $49,000,000 as compared with $46,000,000 during February. This compares with $48,000,000 reported for March, 1944. Production for the first quarter of 1945 totalled $143,000,000.

Plate glass production for the month of April was 8,488,938 sq. ft., as reported by the Hughes Statistical Bureau. This is a decrease of approximately 5 per cent from the preceding month and an increase of 5 per cent over April of last year. For the first four months of 1945 a total of 33,763,118 sq. ft. was produced, as compared to 32,507,720 sq. ft. produced during the same period in 1944.

Glass container production for April was reported at 8,524,432 gross—a decrease of about 3 per cent from production during March and a very slight decrease from the figure reported for April, 1944. During the first four months of 1945 glass container production totalled 32,862,951 gross, as compared to 33,436,157 gross for the same four months of last year.

Shipments of glass containers during April (including export shipments) were 8,975,871 gross, compared to 9,298,440 gross for March—a decrease of about 3 per cent. Total shipments reported for the first four months of 1945 were 34,126,173 gross.

Inventories on glass containers for April were 4,412,568 gross, a decrease of about 8 per cent from the figure reported for March. This compares with 4,793,131 gross for April, 1944.

Automatic tumbler production for April totalled 4,713,610 dozens, representing a decrease of about 14 per cent from the preceding month of March and an

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures Are in Gross)

		Production *Apr.* 1945	*Stocks* *Apr.* 1945
Foods; Medical & Health Supplies; chemical, Household, Industrials; Toiletries & Cosmetics	Narrow Neck	2,755,995	1,759,036
	Wide Mouth	2,661,894	1,113,207
Dairy Products		299,493	274,399
Home Canning		221,769	357,358
Beverages		675,143	342,791
Beers		1,085,183	153,797
Liquors		532,119	304,663
Wines		202,016	94,338
Packers' Tumblers		90,820	12,979
Total		8,524,432	4,412,568

GLASS CONTAINER SHIPMENTS

(All Figures Are in Gross)

	Apr. 1945
Narrow Neck Containers	
Foods	654,139
Medical & Health Supplies	1,113,489
Chemical, Household, Industrials	589,310
Beverages	651,737
Beers	1,016,463
Liquors	511,985
Wines	211,589
Toiletries & Cosmetics	516,356
Sub-Total (Narrow Neck)	5,265,068
Wide Mouth Containers	
Foods	2,235,068
Dairy Products	288,783
Home Canning	298,702
Medical & Health Supplies	326,690
Chemical, Household, Industrials	94,442
Toiletries & Cosmetics	157,689
Packers' Tumblers	95,757
Sub-Total (Wide Mouth)	3,497,131
Total Domestic	8,762,199
Export Shipments	213,672
Total Shipments	8,975,871

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increase of 10.3 per cent in comparison with the corresponding month of April, 1944. Shipments of automatic tumblers for April totalled 5,124,409 dozens as compared to 4,948,916 dozens for March and showed an increase of 8.7 per cent over April a year ago. Finished stocks on hand as of the end of April were 4,352,728 dozens as compared to 6,392,536 dozens for April, 1944—a decrease in inventory of 31.9 per cent.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware for April were reported at 2,795,570 dozens, which showed a slight decrease from the 2,838,047 dozens shipped in the preceding month, but a decided increase of 52.1 per cent over the corresponding month of April, 1944. Shipments for the twelve-month period ending April, 1945, amounted to 31,436,593 dozens.

Employment and payrolls: The total number of persons employed in the glass industry during March were 88,300. This compares with 87,600 employed in January, and with 92,000 employed during March, 1944.

Payrolls for March were $15,000,000 as compared with $14,500,000 for February. During the first quarter of 1945 glass manufacturers paid approximately $44,000,000 in salaries.

GLASS CONTAINER INSTITUTE . . .

(*Continued from page* 278)

Committee on Testing Procedures. This Committee, one of those of paramount interest and value to the users of glass containers, as well as to the glass manufacturers, will "conduct and provide experimental activities in connection with the diagnosis and elimination of manufacturing imperfections, the reduction of breakage, the reduction of weight of glass containers, the maintenance of glassware quality and the definition of glassware characteristics, and other technical problems of the industry."

Technical Committee on Glass Packed Products. As in the case of the Committee mentioned above, the work of this Committee as well as those, an outline of whose functions will follow, will be of direct benefit to manufacturers whose products are glass packed and bottled. The Technical Committee work will concern the effects of packing and bottling on food, beverages and other products packed or bottled in glass. It will devote itself to the improvement and better preservation of such products and conduct and provide for experimental activities with regard to the relative merits of packing and bottling in glass and other types of containers. It will also provide for the testing of the results of its activities by the proper governmental authorities and others.

Committee on Standards for Finishes. In a brief preamble to the specific aims of this Committee it is stated that it "shall develop standards for glass container finishes, so that there may be as many manufacturers as possible competing for the sale of glass containers, and in connection therewith, shall among other things: (a) Engage in experimental efforts to improve manufacturing efficiency and better sealing practices; (b) Develop and, from time to time, modify standard sizes of and specifications for finishes of glass containers with a view

(*Continued on page* 298)

NEW EQUIPMENT AND SUPPLIES

VACUUM-TUBE ANTICIPATOR CONTROLS FURNACE TEMPERATURES

Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., has announced the development of a vacuum-tube thermocouple device characterized by its anticipating nature, which increases the sensitivity and response of conventional temperature controls by a thousand per cent.

This instrument consists of two thermocouples of different thermal capacity and an electric heating element, enclosed in an evacuated glass envelope to cause heating of the thermocouples by radiation, to minimize room temperature effects, and to prevent deterioration of the elements. Changes in electric furnace temperatures are anticipated and corrective steps taken to minimize the cyclic swings in temperature characteristic of most furnace controls.

NEW METALLIC COATINGS

The O. Hommel Company of Pittsburgh, Pa., has developed special metallic coatings which are being used by the electrical industry as a conductive surface. This surface can be used not only for conductive purposes but also as a base for soldering. It is adaptable to a glass surface as well as a glazed or unglazed ceramic body. A special product for use on mica in condenser work has also been developed. The material can be prepared for spraying, hand painting, printing through a silk screen and dipping.

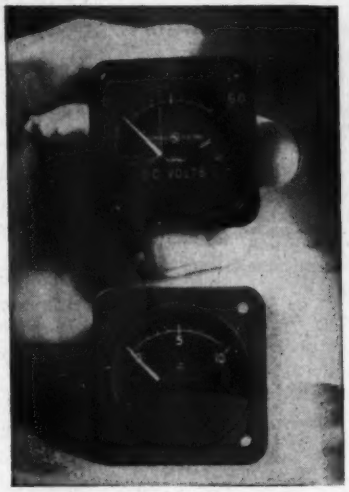
SPECIAL ANTI-FREEZE PASTE

The O. Hommel Company, Pittsburgh, Pa., has developed "Easi-Release" a special anti-freeze paste that is applied to steel or stainless steel nuts, bolts, or any other screwed devise that is subjected to high temperature where corrosion might take place because of heat and fumes, thereby making it almost impossible to take apart after it has been in service without breaking. This product is applied by dipping or spraying on the object before it is screwed into place.

CLIMAX ENGINEERING ENTERS ELECTRONICS FIELD

The Climax Engineering Company of Clinton, Iowa, has announced its entry into the field of electronics. All preliminary engineering has been completed and pilot models constructed. Actual production awaits approval of the WPB. The new product will be known as the Climax High Frequency Heater.

The Climax product provides quick, efficient, localized heat for surface hardening, annealing and brazing. Climax expects to produce 12 models of standard electronic heaters and is establishing an Electronics Division for their manufacture, engineering, distribution and sales.



ELECTRIC INDICATING PANEL INSTRUMENTS

General Electric Company's Meter and Instrument Division has announced a new line of 1½-inch electric indicating panel instruments, components of most communication and electronic devices. Two forms are available: a watertight design for application where the equipment may be accidentally submerged in water, exposed to rain, or used in extremely humid climates; and a conventional design for use in aircraft or for other service where the instrument will be protected from the elements.

Both types will withstand vibration tests specified in American War Standard ASA Specification C-39.2-1944. They are available in nearly all ratings for direct-current, radio-frequency, and audio-frequency measurements, and are mostly for use with external thermocouples or rectifiers.

CONDUCTIVE COATING MATERIALS

E. I. duPont de Nemours & Co., Ceramics Products Division, Electrochemicals Department, Wilmington, Delaware, has conductive coatings, containing a specially prepared silver powder, which produce a surface of low electrical resistance and high conductivity when applied to a variety of non-conductive materials. Typical base materials to which these coatings can be applied are glass, porcelain, steatite, plastics, etc. Aging or exposure to sulfides has only a slight effect on the conductivity of the coatings.

Sample of Conductive Coating Materials for evaluation purposes will be furnished upon request sent to the above address.

CATALOGUES RECEIVED

Clipper Manufacturing Co., St. Louis, Missouri, is distributing an attractive 32-page, loose-leaf booklet "An Index . . . to cutting information." The book was written after a survey was made on the cutting of masonry materials and refractories, and the information contained therein will be of help to those who are interested in this particular field.

Harbison-Walker Refractories Company, Pittsburgh 22, Pa., has just issued a new folder "Five Insulating Brick of Prime Importance to Refractories Users." The manufacturer claims that in these products light weight, essential to high insulating value and to low heat storage capacity, has been attained without sacrifice of the mechanical strength necessary to insure minimum loss through breakage in transit and in normal handling.

The B. F. Goodrich Company, Akron, Ohio, has a new broadside describing, with pictures and text, many applications of the Punch-Lok safety clamps used in the newest method of banding hose or splicing cable.

The clamps are available in two types, the pre-formed, complete rings which are shaped to slip over the ends of hose, nipples, connections, or other sections to be joined and the open-end, straight bands made to permit curving around hose, cable or other objects that need binding.

Eutectic Welding Alloys Co., 40 Worth Street, New York, N. Y., recently issued an attractive four-page folder titled "Eutectic 'Low Temperature' Welding Alloys." Among the outstanding features claimed for EutecRods and EutecTrodes are: Unusually low bonding temperatures that prevent distortion; less preheating of parent metal required; less after machining and cleaning, etc.

Specific applications, uses and specifications on design and procedure of the various rods are also featured.

Precision Scientific Co., 1750 North Springfield Avenue, Chicago 47, Illinois, has issued Cataalogue 325 containing forty-eight illustrated pages pertaining to "Precision" Freas Constant Temperature Control Cabinets, including an extensive variety of standard models, as well as many photographs of constant temperature cabinets and baths built to specifications. Included also is general information pertaining to mechanical and gravity convection heat transfer.

SURFACE DEALKALIZATION OF FINISHED GLASS . . .

(*Continued from page* 277)

migration of alkali ions, is known to decrease during annealing. The differences between the chemical resistivities of annealed and unannealed glasses depend on their composition. Approximately 10-20% improvement can be obtained through the annealing operation. A similar increase (about 10%) during annealing has been found for the activation energy of the sodium ion as determined by the electric conductivity. (A. Smekal[9]) The migration of alkali to the surface during annealing affects the chemical resistivity in the opposite way; it can increase the amounts of alkali which can be dissolved from the surface several hundred per cent.

The effect of constitutional changes during annealing is, therefore, of minor importance, if the alkalinity of the glass surface is measured. More important, in this respect, is that the effect of the alkali migration on the surface alkalinity can be counteracted by its volatility, especially under reducing conditions, and by its reaction with furnace gases. Annealing in open lehrs where the glass is exposed to combustion gases has been found to improve the chemical resistivity. The alkalinity of a glass surface is affected by the annealing operation in a three-fold way:

(a) Increased by the migration of alkali to the surface due to surface tension.
(b) Decreased by structural changes.
(c) Decreased by volatilization and the reaction of alkali with furnace gases.

If one wants to study the migration of alkali to the surface, one has to eliminate the last two processes. A most informative study of the alkalinity of a glass surface as a function of the heat treatment was made by Keppeler and Heckter[10]. The results of their work will be discussed in detail.

Glass tubes, 100 mm. long and 7 mm. outside diameter, were used for these experiments. Their composition was as follows:

SiO_2	71.0%
Al_2O_3	3.7
CaO	6.4
Na_2O	13.5
K_2O	5.0

The alkalinity was determined by treating the tubes (three pieces) with water at 80°C. for three hours. The amount of alkali thus extracted was titrated with HCl using methyl red as an indicator. Samples were heated in an electric muffle furnace to 450, 500, and 575°C. For all temperatures it was found that the surface alkalinity increased with the time of heating. Figure 1 shows the amount of alkali (mg. Na_2O) extracted from 100 cm^2 of the heated glass surface as a function of time. The alkalinity of the surface increases with time and temperature.

Keppeler and Heckter were also interested in finding out whether or not this change of the alkalinity is limited to the extreme outer surface layer. For this purpose they compared the amount of alkali withdrawn by repeated extractions from samples, with and without heat treatment. From Figure 2 we see that the amount of alkali obtained during subsequent extractions decreases as one would expect. But in every case the sample which had previously been held at 550°C. for seven hours gave off more alkali than the untreated blank. The total amount of Na_2O extracted from the heat treated sample is about twice that from the untreated glass (Figure 3).

Removal of Alkali from the Surface Layer Due to Its Reaction with Furnace Gases

Surface tension leads to the establishment of a positive concentration gradient of Na_2O from the interior of the glass to the surface. This effect is often obscured by a second effect produced by the reaction of the glass with furnace gases, especially with sulphur dioxide. Such a reaction produces a negative concentration gradient, and leads to a glass with a lower alkali content at its surface.

From a practical point of view, this is desirable, because it improves the chemical resistivity of the glassware and lowers the surface conductivity. Improved chemical resistivity has been observed also when glassware was exposed to the action of furnace gases during annealing. One of the most interesting studies in this respect deals with the surface alkalinity of test tubes. H. Loeber[11] found that annealing the open tubes improved their resistivity. However, when the test tubes were sealed before annealing, their surface alkalinity increased. In order to determine the depth action of the annealing, six subsequent extractions were made at 80°C. Table II gives the extraction figures in mg. of Na_2O for 1,000 cm^2 of glass surface.

The improvement of the chemical resistivity of a glass by furnace gases was studied extensively by G. Keppeler and his students. Keppeler[12] found that annealing improved the chemical resistivity of the bulk of the glass (powder method) between 10% and 20%, but the presence of sulphur dioxide in the furnace gases improved the surface resistivity several hundred per cent.

It was well known to the old glass-blower that one side of the hand made window pane was much better than the other. The better side was the one which had been exposed to the furnace gases during the stretching operation.

TABLE II

		Annealed					
	Un-	Open tubes			Closed tubes		
Extraction	annealed	1x	2x	3x	1x	2x	3x
1	49	35	15	5	51	50	49
2	23	29	14	5	33	35	42
3	18	16	5	2	20	30	20
4	13	14	3	1	17	22	18
5	8	6	3	0	15	22	18
6	8	2	1	0	13	19	17
Total alkali withdrawn by the six extractions	119	97	41	13	149	178	164

Also in the Fourcault process a slight but distinct improvement of the glass surface was noticeable due

to the leaking of furnace gases into the drawing chamber. Because heavy panes have to be drawn more slowly than thinner ones, their surface is exposed to the furnace gases for a longer time. Keppeler[13] found that heavier panes, therefore, have a better surface resistivity.
panes, therefore, have a better surface resistivity. In 1930, a patent was granted to Keppeler[14] for a process for improving the resistivity of the inner surface of bottles by dropping in materials which produced reactive gases, such as sulphur dioxide.

In England, the beneficial influence of furnace gases has been discussed repeatedly in connection with the advantages and disadvantages of the modern muffle lehrs. A. Cousen[15] made a critical examination of the standard procedure to test for the chemical durability of glass bottles. He arrived at the following conclusions:

1. With the open lehr (access to SO_2) the amount of alkali extracted from wide-mouth jars is very much smaller than that from narrow-mouth jars, the ratio being approximately 1 to 4.
2. The wide-mouth jars annealed in open lehrs give a much lower result than similar jars annealed in a muffle lehr.
3. With the muffle lehr there is no appreciable difference in the results for narrow and wide-mouth bottles.

C. J. Peddle[16] emphasizes that this improvement of the chemical resistivity might be an important reason for many glass plants delaying their change from the older open lehrs to modern equipment. He expressed his opinion on this subject as follows: "There are certain types of bottles and jars which on account of shape or size have a very narrow margin of safety on the score of strength and durability. Regarding this strength factor the open-fired lehr appears to provide a higher margin of safety and so has justified its continued use for this kind of ware."

Besides this technical experience derived from plant control we have also two laboratory studies on the reaction of glass with an atmosphere containing sulphur dioxide. J. N. Coward and W. E. S. Turner[17] determined the amount of sulphate formed on the surface of a soda lime glass containing approximately 15% Na_2O. The influence of temperature, time, and repeated treatments was studied. Table III gives some average values expressed in mg. for 100 cm^2 of glass surface. At temperatures of 650°C. and higher the glass showed signs of permanent attack, "burned-in-bloom."

TABLE III

Temperature	Gain in Weight	Loss after Washing	SO_4 Formed
550°C.	7.2 mg/100cm²	3.1 mg/100cm²	4.5 mg/100cm²
600°C.	6.8 "	4.3 "	6.1 "
650°C.	7.0 "	4.9 "	7.4 "

Of interest in respect to our previous discussion are the results which Coward and Turner obtained with blanks. In order to interpret gain in weight and loss after washing, some samples were given the same heat treatment but without the presence of sulphur dioxide. As the authors expected, these samples did not show appreciable change in weight when treated at temperatures below 650°. Above this temperature, however, the washing water showed a marked and determinable alkalinity. This effect, which the authors intend to study further, is no doubt the result of surface tension causing the alkali to migrate to the surface.

T. V. Takats[18] studied the reaction of various alkali and lead silicates with an SO_2-oxygen mixture. Finely powdered glasses of rather basic compositions were used and the experiments were carried out over a period of two hours. Table IV gives the reaction of the various alkali silicates as a function of composition and temperature. The reaction is expressed in per cent of the possible conversion of alkali into the sulphate. There are other papers and patents published which deal with the alkali in glass, but all of them are more or less based on the reaction of the surface alkali with gases or vapors of industrial furnaces.

TABLE IV

	Reaction in %					
	300°C.	350°C.	400°C.	450°C.	500°C.	550°C.
Na_2O,SiO_2	3.5	6.0	10.5	20.9	32.5	37.5
$Na_2O,2SiO_2$	8.9	12.2	22.7	48.4	54.2	60.9
$Na_2O,3SiO_2$	5.5	4.3	5.0	4.8	5.2	5.2
$Na_2O,4SiO_2$	2.9	3.0	3.6	3.6	3.7	3.9
Li_2O,SiO_2	—	2.7	—	12.4	18.0	20.0
K_2O,SiO_2	4.0	4.0	8.5	17.8	37.9	39.3

Other Reactions Leading to the Removal of Alkali from the Glass Surface

The exposure of a glass surface to combustion gases or acidic vapors represents only one of the possibilities to remove a part of its alkali. The chemical reactions which can be used to dealkalize the glass surface can be divided into two main groups.

(1) Replacement of Na^+ by other cations such as H^+, Ag^+, or Cu^+.
(2) Subtraction of Na_2O.

The reactions of the first group have been studied extensively both from a practical and a scientific point of view. Some of the most important changes of the glass surface belong in this group. The chemical attack by water or diluted acids, for instance, begins with the substitution of H^+ for the alkali ions. Later, other network modifying ions will be replaced and finally the glass surface is changed into a layer of silica gel. Under controlled conditions this destructive reaction can be used to produce low reflection films. F. L. Jones[19] improved this method by combining two base exchange reactions, one substituting Ag^+ for Na^+, the other H^+ for Na^+ and Ag^+. Silver ions are allowed to penetrate deep into the glass, replacing an equivalent number of sodium ions. A second treatment aims to substitute hydrogen ions for those Ag^+ and Na^+ which are present in the extreme outer surface layer. The first process increases, the second one decreases the index of refraction and the proper combination helps to decrease the intensity of reflected light.

The replacement of Na^+ by Ag^+ and Cu^+ has also been used to produce colored glass (the silver and copper stain).

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SURFACE DEALKALIZATION OF FINISHED GLASS . . .

(*Continued from page* 291)

All these base exchange reactions have a low activation energy so that they can take place at relatively low temperature. E. C. Marboe and W. A. Weyl[20] pointed out that base exchange processes are the first step in many chemical reactions leading to the deposition of mirrors on a glass surface. Most silvering processes begin with the replacement of alkali ions by silver ions and subsequent reduction to metallic silver. The same has been found for the deposition of copper from cuprous ion-phenylhydrazine mixture. The first step, the substitution of Cu^+ for Na^+ takes place easily at about 50°C.; the analogous silver reaction occurs at room temperature.

If there are no monovalent cations which can replace the Na^+ or K^+, their removal from the glass has to be accompanied by the removal of an equivalent amount of anions. Normally oxygen ions are removed simultaneously with the sodium ions and we speak then of the removal of Na_2O. We may do so if we realize that Na_2O is not diffusing as a unit or a molecule, but that its three ions, two Na^+ and one O^{2-} migrate separately. For such a diffusion process where several ions move and their motion is interdependent, W. Nernst[21] has derived the following equation:

$$\frac{1}{D_{Na_2O}} = \frac{2}{3D_{Na^+}} + \frac{1}{3D_{O2--}}$$

That means, the time necessary for the diffusion of Na_2O is dependent on two relationships; one given by the time required by the sodium ions and the fraction of the total number of moving units which are Na^+; the other by the corresponding value for the oxygen ions.

From the coefficients of diffusion D_{Na^+}, D_{H^+}, D_{Ag^+} and so on, we derive in the same way the rate of the base exchange reactions, e.g.,

$$\frac{1}{D} = \frac{1}{2D_{Na^+}} + \frac{1}{2D_{Ag^+}}$$

These relations indicate that the progress of the migration is determined chiefly by the slowest moving unit. It becomes evident, therefore, that the withdrawal of Na_2O involving the doubly charged oxygen ion is a much slower process than the migration of NaF, NaCl, or the base exchange between Na^+, H^+, and Ag^+.

The probability of breaking a silicon-oxygen bond in a glass increases with temperature and from the thermal expansion and the change in density or refractive index with the temperature we learn that atomic rearrangements requiring the breakage of major bonds are negligible below 400-500°C. but become significant above that temperature range. Whenever we observe a reaction below this temperature we can be fairly sure that we are dealing with a base exchange. The formation of sodium sulfate on a glass surface exposed to SO_2 below 400°C. should therefore be written:

$$2\ Na^+\ Glass^- + SO_2 + 1/2\ O_2 + H_2O = H^+\ Glass^- + Na_2SO_4$$

It involves the participation of water either from the adsorbed film or from the atmosphere. As the temperature increases this base exchange becomes less and less important and above 500°C. the diffusion of Na^+ and O^{2-} to the surface, that is the removal of Na_2O from the glass, predominates.

$$Na_2O + SO_2 + 1/2\ O_2 = Na_2SO_4$$

The removal of alkali from the surface of silicate glasses by the reaction with solid compounds was hitherto unknown. In the following paragraphs shall be described some reactions of this type and also the methods employed to follow the dealkalization of the surface.

In the course of this investigation it was found that practically all compounds which can combine with Na_2O at high temperature are suitable reagents for dealkalizing the glass surface. This can best be illustrated by comparing thorium oxide, ThO_2, with zirconium oxide, ZrO_2. Only the latter is able to withdraw the alkali from the glass surface whereas the otherwise very similar thorium oxide proved to be completely ineffective. This is in accordance with the fact that despite their chemical similarity, ZrO_2 may form sodium zirconate whereas according to D'Ans and Loeffler[22] a corresponding thorium compound does not exist.

Dealkalization of the Glass Surface by Means of Metakaolin

A. *Chemical Reactions of a Glass Surface with Clay or Metakaolin*

Most of our experiments were carried out with kaolin which had been purified by electrodialysis. It is an established fact that the ultimate clay crystals carry a net negative charge which results either from anionic complexes adsorbed at their surface or from an unbalanced crystal lattice. The clay minerals may therefore be considered huge anions and that explains why they can adsorb a certain number of cations such as Na^+. Electrodialysis removes these cations and substitutes hydrogen ions.

The low temperature reaction between the glass surface and the clay consists of a base exchange reaction which may be written:

$$Na^+\ Glass^- + H^+\ Clay^- = H^+\ Glass^- + Na^+\ Clay^-$$

The amount of replaceable hydrogen, the base exchange capacity, depends largely on the nature of the clay. It is high for montmorillonite and low for kaolinite. It is customary to express this property in milliequivalents per 100 grams of clay. According to R. E. Grim[23] the base exchange capacity of kaolinite ranges from 3 to 15 m.e./100 g. and that of montmorillonite from 60-100. Illite, another clay mineral, has a medium exchange capacity of 20-40. For all purposes where the replacement of Na^+ by hydrogen ions is desirable, clays with high exchange capacities are to be recommended. This is also true if the dealkalization, that is the removal of Na_2O, shall be carried out in two steps, namely, substitution of H^+ for Na^+ at low temperature and removal of water at higher temperatures. For the removal of Na_2O in one step, the nature of the clay minerals becomes rather immaterial.

In the temperature range of about 500°C. compounds are formed between alkali and clay which may have several compositions. The compound $Na_2O \cdot 2Al_2O_3 \cdot 4SiO_2$ was obtained by W. Büssen and W. Dawihl[24] when kaolin

(*Continued on page* 301)

INVENTIONS AND INVENTORS . . .

(*Continued from page* 285)

in patent 2,373,082 assigned to Owens-Corning Fiberglas Corp. by Carl G. Staelin of Ottawa Hills, O.

Fig. 4 is from Louis A. Hawthorne's patent 2,373,183 assigned to Johns-Manville Corp. It shows apparatus for building up a mineral wool blanket or block from nodules of the fibrous material. These are delivered by means of conveyor 22 and are swept from it by a rotating wiper 70 into a hopper 46 which rests upon a larger conveyor. The wiper has deflecting blades which counteract the tendency of the nodules to be swept obliquely from the fast moving supply belt.

Another Johns-Manville patent is 2,373,500 which was granted to Gale T. Pearce of Somerville, N. J. When mineral wool is blown into a collecting room and allowed to come to rest on a conveyor upon which it is compressed to form a mat, there is a tendency for stratification. To overcome this tendency Pearce saws the matted column into a number of small strips and runs them through guides which turn each strip ninety degrees. Then they are led back together, recombined, and the whole column faced on both sides with paper as a bonding means.

VAN PELT APPOINTED TO STAFF OF BATTELLE

Battelle Memorial Institute, Columbus, Ohio, has announced the appointment to its staff of J. Robert Van Pelt, formerly Technical Director of The Museum of Science and Industry in Chicago.

Mr. Van Pelt will assume responsibility for an expanded program of "Research Education" the name which has been given to the Institute's two-fold program of basic research serving two interrelated ends: It contributes to the advanced professional training of young scientists and technologists; and it adds to the world's store of basic scientific knowledge.

Battelle fellowships, after fifteen years of notably successful operation at Ohio State University, will now be made available in a number of other institutions of higher learning.

PERSONNEL CHANGES AT CORNING GLASS

Two changes in personnel have been announced by the Corning Glass Works. James L. Knapp has been made production superintendent of the Central Falls, Rhode Island, plant, succeeding D. K. Shaddock who was recently elevated to the position of plant manager at Central Falls.

The company also announced the appointment of Paul T. Clark, superintendent of handmade production at Corning Glass Works, Charleroi, Pennsylvania, plant, as production superintendent at the Fall Brook Plant in Corning, filling the position formerly held by Mr. Knapp.

Mr. Clark, a graduate of Corning Free Academy and Cornell University, joined the Corning Glass Works in 1934 as a laboratory assistant at the Main Plant. Mr. Knapp, upon his graduation from Alfred University in 1935, joined the organization also as a Main Plant laboratory assistant.

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GOVERNMENT CHARGES MONOPOLY . . .

(*Continued from page* 282)

latter export no flat glass to the United States; and by

(a) Acquiring subsidiaries and affiliates in foreign countries and licensing them under their patents, present and future, and permitting such companies to sublicense to foreign concerns only on condition that the latter do not export flat glass to the U.S.A.;

(b) Increasing the capital investment owned by them in foreign concerns (including Japanese) on condition that the latter export no flat glass to the United States;

(c) Refusing to permit their jobbers and distributors to resell flat glass outside the United States.

Control of the domestic market was further maintained through agreements and understandings with Rolland, Corning, Blue Ridge and Franklin, and through the National Glass Distributors Association. The Association's membership consists of practically all distributors and jobbers of flat glass in the United States who buy flat glass directly from the manufacturers and who sell flat glass to other jobbers. The Association maintains price lists to both members and non-members and thus fixes "secondary" prices of flat glass.

Rolland Glass Company, together with its subsidiary Adamston Flat Glass Co. of Clarksburg, owns a majority of the capital stock of Fourco.

Blue Ridge Glass Corporation has not manufactured flat glass since 1929. It manufactures rolled, figured and wire glass.

Corning Glass Works is engaged principally in manufacture and distribution of such glass products as incandescent bulbs, signal, oven and optical ware and other specialty glass. It does not make flat glass but conducts extensive research in flat glass tempering and other processes used in the manufacture of flat glass.

Franklin Glass Corporation is owned by French and Belgian glass manufacturers and manufactured approximately 4% of the plate glass in the United States.

American Securit Company is a patent-holding company organized by Corning and certain French and Belgian flat glass manufacturers. It acquires and licenses tempering and other processing patents.

Relief Sought

The complaint asks: Divestiture of all flat glass plants, except one each, owned by Pittsburgh Plate Glass Co., Libbey-Owens-Ford, American Window Glass Co. Dissolution of Fourco and the National Glass Distributors Association. Cancellation of all restrictive agreements between the American and foreign companies. Royalty-free licensing on all existing patents and compulsory licensing on a reasonable royalty basis of all patents acquired in the future, including improvements on existing patents. Divestiture by Pittsburgh Plate Glass Company of its 106 warehouses and retail stores.

The case is in charge of Curtis Shears, Special Assistant to the Attorney General, under the general supervision of Holmes Baldridge, in charge of the General Litigation Section of the Antitrust Division, and Assistant Attorney General Berge.

BIRCH NAMED DIRECTOR OF RESEARCH FOR HARBISON-WALKER

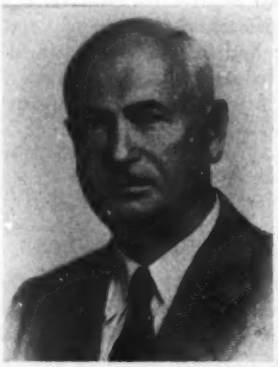
Announcement has been received of the appointment of Raymond E. Birch as Director of Research for the Harbison-Walker Refractories Company to succeed the late Fred A. Harvey.

Mr. Birch has been associated with the company since 1930. He graduated in Ceramic Engineering from Ohio State University in 1927 and received the profession degree of Ceramic Engineer in 1937. His fields of investigation have included work in vacuum pressing of refractories, development work on silica, magnesite and forsterite refractories, etc.

Mr. Birch has been active in the American Ceramic Society and is a member of the Institute of Ceramic Engineers, the Society of Glass Technology, the American Institute of Mining and Metallurgical Engineers, the British Iron and Steel Institute and is a Fellow of the American Association for the Advancement of Science. He was an organizer and is now vice-president of the Pittsburgh Geological Society.

EISLER ENGINEERING CELEBRATES TWENTY-FIFTH ANNIVERSARY

In June of 1920, Charles Eisler founded the Eisler Engineering Company of Newark, New Jersey. The original plant employed only a few men but it was an ambitious business for it specialized in the design and manufacture of automatic machinery essential to the mass production of incandescent lamps, radio and electronic tubes and accessories.



Most of Eisler's new ideas in automatic machinery have been for designs for the lamp industry and include tools and implements necessary for the manufacture of incandescent lamps, radio, neon and electronic tubes and accessories. The most widely known of the Eisler equipment includes sealing-in machines, exhaust machine mechanisms, stem heads, gas purifiers, annealers and furnaces, automatic cutters, high vacuum pumps and electric spot and buttwelders and transformers.

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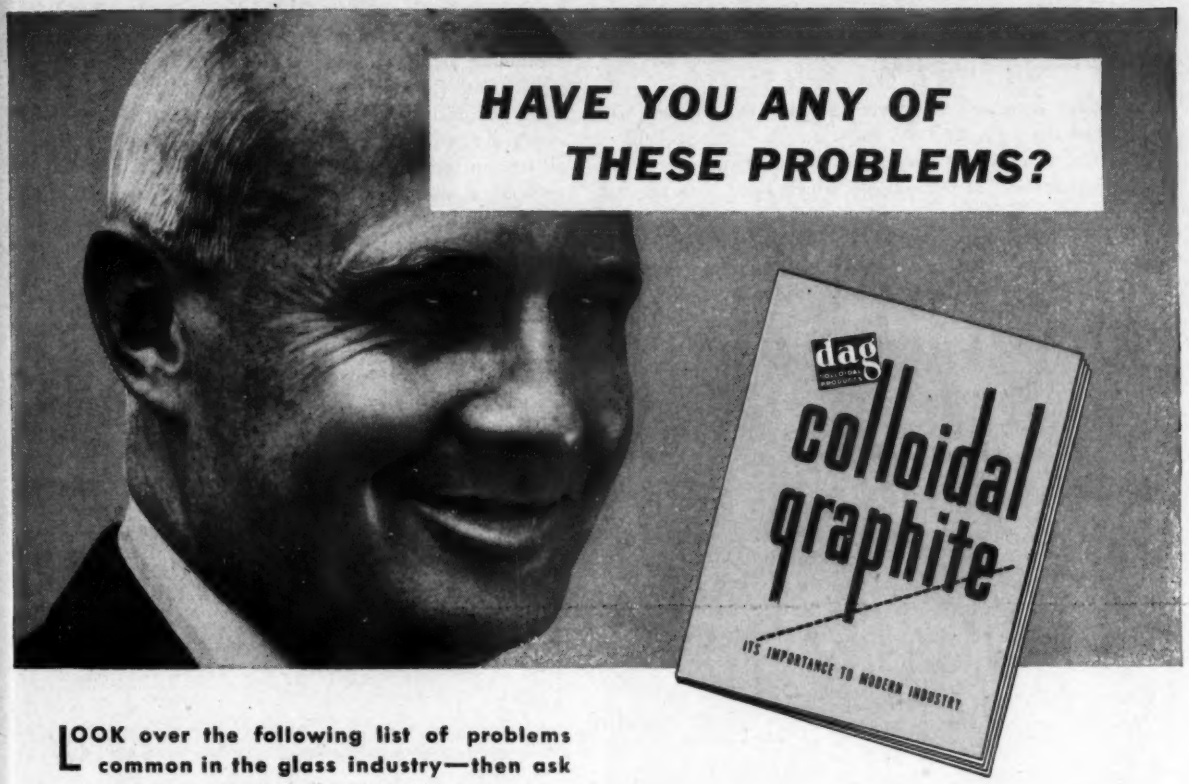

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BASIC REGENERATORS . . .

(*Continued from* page 281)

novation because of previous sad experience with plugged checkers, and are fully aware of the difficulties involved in cleaning continuous flues. However, a simple examination of the settings which have gone through a campaign will illustrate the logic and reasoning behind the recommendation. The sides of the basic brick remain clean, with the brands still visible. Some of the exposed horizontal surfaces show evidence of a

Fig. 7

slight build-up, which would not be present with continuous flues, except for the top course, because all other exposed surfaces are vertical. For the top course, No. 3 arches or, in extreme cases featheredges, may be placed in the usual number of rows. Thus the batch carryover has no opportunity to find a resting place until it reaches a point seven or eight courses down, where the standard setting is employed for another six courses, and these can be readily cleaned.

Were it not for the condensation of volatile alkalies, first quality clay brick could be used under the basketweave section; by continuing the basic brick for the depth specified, substantially all of the carryover passes through the entire setting to the flues. The use of the basic basketweave setting has been thoroughly tested without the help of the basic superstructure at temperatures in excess of 2600° F. It has quadrupled the checker life formerly obtained, with the added advantage of full regenerative efficiency for the entire period, in spite of considerable slagging of the uptakes and regenerator crown.

The first installation of unburned chrome brick in the back half of the regentrator crown has been in service sixteen months. The same type of brick is used in the uptakes and uptake caps, with the result that slag has been completely eliminated in that portion of the regenerator. While the use of unburned chrome brick in sprung arches is comparatively new to the glass industry, such arches have been used for spans up to 16′ in the copper industry for a number of years. The combination of unburned chrome superstructures with unburned magnesite basketweave settings should enable operators of hot tanks to forget checker replacements from one rebuild to another, and to forget uptake replacements for two or three campaigns.

In comparing the cost of basic brick with that of less expensive refractories, it is only fair to take into consideration the saving in labor for checker removal at the time of a rebuild. With badly slagged checkers of the silica-alumina type, it is not unusual for a gang of five or six men to spend a full week in cleaning out both regenerators. Such experiences pass into the realm of bad dreams with the advent of non-slagging basic brick, which can be removed as rapidly as they can be hauled away.

Insulation of these basic superstructures is also wholly feasible, because no eutectics are formed at the highest operating temperatures. Thus, there is a distinct possibility that a portion of the heat, normally dissipated through the superstructure, may be conserved. The result would be somewhat higher checker temperatures, which should permit a proportionate economy in fuel. An intangible advantage would be the more comfortable working conditions around the uptakes, as 1½″ of block insulation would reduce the cold face temperature from a normal 500° F. to less than 300° F.

GLASS CONTAINER MANUFACTURERS ADVERSELY AFFECTED BY I.C.C. RULING

To just what extent the Interstate Commerce Commission was motivated by political considerations in its recent decision increasing freight rates in the Eastern territory (that area north of the Potomac and Ohio Rivers, east of a line running through Peoria, Chicago and St. Louis to the Atlantic Seaboard), and lowering rates in all other territories west of the Rockies, may be debatable despite a considerable opinion that politics largely influenced the decision.

Regardless of the underlying reasons, however, it is outstandingly apparent that the Commission's ruling will impose severe hardship on a very large portion of the glass packaging industries since the greatest movement of glass containers, packed and empty, is within the area for which a 10 per cent freight rate increase has been prescribed.

This far reaching order is the result of an investigation instituted by the I.C.C. in 1939 on its own motion—the purpose of the action being to determine the need, if any, for a uniform classification and rail freight rate structure throughout the country.

These findings are covered by a report of some seven hundred pages and in it the Commission has entered its first order in this proceeding. Both shippers and carriers are now busy analyzing this order.

PRESTON DECLINES FELLOWSHIP IN A.C.S.

Based on information received from headquarters of the American Ceramic Society last month THE GLASS INDUSTRY reported that Dr. Frank W. Preston had been elected a Fellow of the Society at the curtailed annual meeting held in Buffalo during the week of April 16.

Word has just been received from the Society that Dr. Preston has declined the Fellow Honor and that his declination has been accepted.

PROGRESS WITH CORHART

The Corhart* Electrocast balanced tank shown above recently completed its second Corhart campaign on flint bottle glass. During its first Corhart campaign, the tank contained Corhart Electrocast throughout the melting-end sidewalls, throat, dog-house, and in portions of both the superstructure and the melting-end bottom. . . . For the second campaign, the use of Corhart Electrocast was extended to include additional superstructure, and a larger portion of the melting-end bottom (as well as the entire refining-end sidewalls, and a portion of the refining-end bottom).

The following is the operating data for both campaigns. We believe you will agree that the increased production figures fully justify the description above—"*Progress* with Corhart."

	8/14/39 to 1/8/42	3/5/42 to 1/19/45	Percent of Increase
Melting Area	770.5	770.5	0.0%
Total Days Life	870	1,051	20.8%
Total Operating Days	803	1,018	26.8%
Total Tons Glass Produced	75,631	102,899	36.0%
Tons Glass Per Day (Life)	87	98	12.6%
Tons Glass Per Day (Operating)	94	101	7.4%
Tons Glass Per Sq. Ft. Per Life	98.15	133.54	36.0%

On the third Corhart rebuild of this tank, now completed, the use of improved Corhart Electrocast products was extended. Further progress is expected. Corhart Refractories Company, *Incorporated,* 16th and Lee Streets, Louisville 10, Kentucky.

*Not a product, but a registered trade-mark.

QUALITY ENDURANCE

CORHART ELECTROCAST REFRACTORIES

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● After a radio crystal has been finished to one-millionth-inch tolerance, it *must* be clean! When a special product was needed in war plants to do this job of ultra-precision cleaning, quickly and safely, HUDSON AMERICAN CORPORATION developed SAFE-T-CLEAN.

What's more, SAFE-T-CLEAN has PROVED *itself equally effective not only for mass cleaning quartz crystals but also for cleaning all types of glassware and mirrors!*

● That's why manufacturers of a wide diversity of products welcome the news that SAFE-T-CLEAN is now available for general commercial use . . . manufacturers of pressed and blown ware, bottle and hollow ware, window and polished plate glass, laminated and safety glass, jewelry, sashes and doors, mirrors, ceramics, crystal ware, and quartz crystals.

The coupon below entitles you to try this new and different glass cleaner in your plant-cleaning operations. It brings you a sample 6½-ounce package of SAFE-T-CLEAN — enough for a ½-gallon strong solution or a 1-gallon weak solution, according to your particular needs.

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Specialty Division
HUDSON AMERICAN CORPORATION
25 West 43rd St., New York 18, N. Y.

GLASS CONTAINER INSTITUTE . . .

(*Continued from page* 288)

to manufacturing economies, including the revision of specifications so as to permit maximum interchangeability of neck rings; (c) Develop modifications in finish standards for new types of forming machines; (d) Develop standard glass finish specifications for any new methods of sealing which may be developed from time to time; (e) Make blueprints available setting forth technical data pertaining to finishes and their manufacture, and new and revised specifications for finishes; and (f) Cooperate with the Bureau of Standards in connection with the foregoing.

Committee on Container Design and Specifications. This Committee has as its objective the simplification of glass container design through the establishment of groups of standard containers on which a packer or bottler may rely in size and style. The layout of the glass users filling lines and packing procedures is also a part of the contribution which this Committee is prepared to make to the glass packaging industries. It is felt that if this cooperation is accepted by the packer and bottler it will assure them of glass containers of standard design irrespective of the source of supply. A concomitant of these projected activities would be maximum competition among the manufacturers of glass containers.

Committee on Package Design and Specifications. The principal function and purpose of this Committee relates to all matters concerning the safe, economical and efficient handling of glass containers and the packing and bottling of products in glass. Among its objectives are: the development of methods with a view to economizing in the use of paper and other packaging materials; the development of standard designs and specifications for cartons and other packages; and the promotion of and participation in laboratory investigations of the strength of packaging materials.

The executive personnel of the Glass Container Manufacturers' Institute will consist of a President, First Vice President and Second Vice President, who will be elected annually from the Trustees, and will serve without compensation until the next annual meeting of the Trustees. A General Manager, Secretary and Treasurer will constitute the remainder of the official family of the Institute. These latter officers may be elected or appointed by the Trustees for such terms, conditions and for such remuneration as is deemed advisable by the Trustees. It is provided that any two or more offices except those of President or Vice Presidents may be held by the same person.

Included in the Institute's official set-up is provision for the employment of a General Counsel who will be kept fully informed as to all activities of the organization. It is presumed Fred E. Fuller, who has handled the legal details of the Institute from its inception, will fill this office.

While details of organization have not as yet been settled it is provided that the principal office of the Institute will be placed in Toledo, Ohio, in order to bring the corporation within the jurisdiction of the United States District Court. It is contemplated, however, that the office of the General Manager and the administrative office of the Institute will be maintained at 250 Park Ave., New York City.

GLASS PACKAGES . . .
DISTINCTIVE WITH COLOR

Colorful glass containers for an increasing variety of items will be in demand after the war. Superior use of color and design in decorations, labeling and legend will be the keynote to greater sales.

Look to Du Pont Glass Colors for adding *buy appeal* to the containers you make. These colors are strong in the qualities you need for producing better, more salable lines:

1. HIGH ALKALI-RESISTANCE—Repeated exposure to hot caustic solutions proves the superiority of these colors—their ability to stand up under drastic treatment.
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3. SULFIDE-RESISTANCE—unaffected by constant direct contact with foods.
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5. EASILY APPLIED—give smooth, even applications of exceptionally high gloss—easily adapted to the heaviest of multi-layer designs—without the troubles usually associated with heavy applications.

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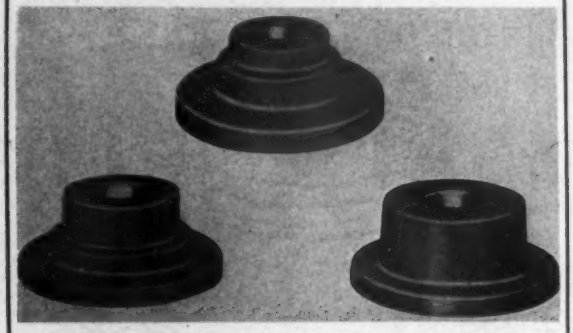
Guide Rings



Like all Gunite glasshouse castings Standard grade A is used for guide rings because it is best adapted to this particular purpose.

There is a suitable Gunite Alloy for every type of glass mould part requirement. Miller plungers and guide rings, neck ring sticks and round bar stock.

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RESEARCH DIGEST . . .

(*Continued from page* 286)

These variations in porosity serve not only as an indication of possible variations in the firing temperature at different parts of the block, but, in addition, show that differences in porosity and texture may be brought about by a variety of causes among which may be cited:

1—Variations in temperature throughout the block during the firing process.

2—Differences in chemical composition or of the texture of the material arising from inadequate mixing prior to the shaping of the block.

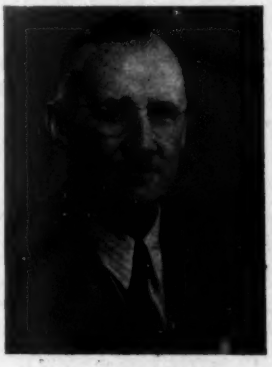
3—Differences in the extent of crack development in the different parts of the block, possibly arising from variation in the rate of heating of the sides and central portions.

4—Differences in the degree of vitrification on the one hand, or crystal growth on the other, at different points of the block, arising from differences of temperature during the prolonged firing at high temperature or from inhomogeneity of material or both.

It was concluded that in any attempt to produce blocks of uniform quality, particular attention must be paid both to the attainment of greater uniformity of composition and texture and also to the firing conditions.

DAHLIN ASSUMES NEW RESPONSIBILITIES AT DIAMOND ALKALI

Announcement has been received that A. H. Copeland, associated with Diamond Alkali Company for a number of years, resigned at the end of April. For some years he operated the coal properties of the Company in West Virginia, and entered the Sales Department in 1928, where he specialized in the marketing of Soda Ash to the glass and steel industries.



George H. Dahlin

George H. Dahlin, as Manager of Glass Industry Sales, will assume Mr. Copeland's sales activities in the glass field. Mr. Dahlin has been associated with Diamond Alkali for twenty-seven years and is well known to members of the glass industry.

SPERLING OF NATIONAL BUREAU OF STANDARDS DIES

Word has been received, from the National Bureau of Standards, of the death of Edward Sperling. He was a master craftsman in the art of blowing glass and for thirty-eight years devoted his skill to the construction of equipment which facilitated the Bureau's work.

Although Mr. Sperling's formal education did not extend beyond that of the public schools, the Civil Service Commission gave him, in his later years, a unique professional status comparable with that of scientists holding doctorate degrees.

SURFACE DEALKALIZATION OF FINISHED GLASS . . .

(*Continued from page* 292)

was treated with sodium nitrate at 500°C. Another possibility is the formation of carnegieite, the high temperature modification of nepheline, $Na_2O \cdot Al_2O_3 \cdot 2SiO_2$, which was observed by E. Gruner[25] when kaolin was allowed to react with sodium carbonate.

For our experiments it is immaterial whether we assume that the dehydration of the kaolin during the dealkalization process leads to a chemical compound (metakaolin) with a characteristic structure or merely to an intimate mixture of finely subdivided Al_2O_3 and SiO_2. Important is, that heating the clay produces a very reactive phase which combines eagerly with the alkali from the glass surface.

The compatibility of Al_2O_3 with glass, especially in the presence of alkali (Na^+Al^{3+} can replace Si^{4+} in the glass structure) causes the clay to stick to the glass if the temperature is above 550°C. or the experiment is carried out over a long time. To avoid this the use of ochre or chromium oxide has been found advantageous.

B. *The Technique used for the Dealkalization Process*

Most of the reactions were carried out with microscope slides (1 in. by 1¾ in.) which consist of a soda-lime glass. Metakaolin was prepared by dehydrating electrodialyzed Zettlitz kaolin at temperatures around 600°C. In other experiments dehydration was allowed to take place during the alkali withdrawal. The latter was preferred because the plasticity of the unfired kaolin made the slip easier to handle and because the preparation of the metakaolin in a separate step did not offer any advantage. In order to bring about intimate contact between glass and reagent, chromium oxide, kaolin, or ochre were made into slips by mixing them with water and thus were transferred to the glass slide. Usually one-half of the slide or a circular spot of about 20 mm. in diameter was covered with the slip. After drying, the sample was heated in a muffle furnace to temperatures varying between 150° and 600°C. for various lengths of time. After the glasses were removed from from the furnace, the clay was washed off and if necessary the glass was scoured. The samples were then tested for alkali distribution by various methods.

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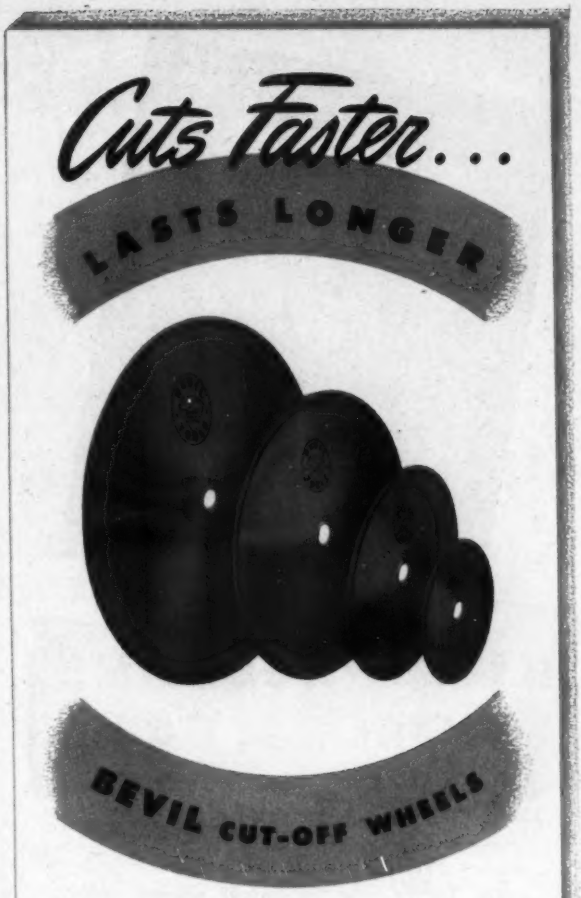

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ELECTRONIC REQUIREMENTS DEVELOP GLASS TO METAL ADHERANCE

The war has forced into its five years at least fifty normal years of progress in the science of Electronics. Not even aviation has changed the technique of war so fundamentally as radio, for the fact that the smallest unit can maintain contact through its earphones with the higher command has made tactics possible which would have been fatal in the old days when communications almost always broke down. The consequence is that with the advent of peace Britain's electronic engineers have ready for their use all sorts of tools and materials invented under the stress of battle needs.

Among other improvements an interesting one is the invention of new types of glass which can be welded into metals. These sealing glasses, as they are called, must have special properties very different from those of ordinary glass. For instance, they must be able in their molten state, when they are being welded or soldered to metal, to *wet* the surface of the metal.

Wetting is a mystery which most of us take for granted. We know probably that a splash of water on a waxed table will roll about like round marbles and not be flat on the surface of the table. But the same water mixed with a little soap can lie flat, come into intimate contact with the table, and in fact *wet the table.* The same sort of thing must happen with the glass and metal, if the joint between them is to be perfectly airtight and strong.

Only certain metals can be used, for in order to allow the glass to wet their surface, they must not evolve bubbles of gas when heated and they must produce a thin oxide surface film for the glass to cling to.

Then again, the glass must be so made that it contracts and expands with changes of temperature evenly with the metal. If this coefficient of expansion is not virtually the same, the glass will crack.

Again, when the glass is sealed to the metal at a high temperature, it is soft and free of strain, but as it cools all sorts of strains will be set up inside it unless it is cooled very slowly and in such a way that all parts of the glass are always cooling at the same rate and none allowed to become cooler than any other part.

Thus a great deal of research has had to be carried out into the right sort of metals, the right sort of glass and then the right way of carrying out the sealing process. But for the enormous progress in radio and electronics generally there would have been no incentive for all this research; so that we owe a great deal of our new knowledge, useful when peace comes, to the need of the hour.

The British glass that has been evolved is called CHANCE G.H.I. but, although this very special glass has excellent properties, it can only be used when the metal to be sealed to it is of a very small diameter of half a millimeter or less. If the metal is thicker than this, a more complicated process has to be carried out; between the metal and the G.H.I. glass a different glass called G.S.I. has to be inserted. The G.S.I. glass seals to the metal on one side and to the G.H.I. glass on the other and then the result is a perfect seal.

That may sound complicated enough, but it is only the beginning: if the metal is molybdenum, as so often in electronics, a third glass, Chance G.S.4 has to come

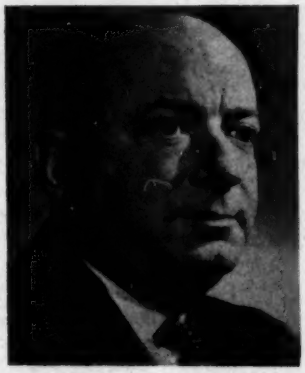
between the molybdenum and the G.S.I.; and if an alloy like Kovar or Fernico is used, then Chance G.S.3 has to be inserted between the alloy and G.S.4.

In short, an electronic tube needing a certain seal between its metal parts and glass bulb must be sealed with a succession of substances thus: Kovar—G.S.3—G.S.4—G.S.I.—G.H.I.

JOHN-LANGDON DAVIES, M.B.E.

FOSTER-FORBES ELECTS BARNARD A DIRECTOR. COMPANY ANNOUNCES PURCHASE OF DEMUTH GLASS.

Announcement has been made by the Foster-Forbes Glass Company, Marion, Indiana, of the election of R. H. Barnard to the Board of Directors of that Company.



Foster-Forbes has also announced that it has purchased all of the stock of the Demuth Glass Works, Inc., Brooklyn, New York, with plants located in Brooklyn and Parkersburg, West Virginia. The Demuth Glass Works, Inc., will operate as a wholly owned subsidiary. Mr. John G. Clarke will remain as President of Demuth.

It is the intention of Demuth to continue to produce glass products for the industrial and illuminating fields, and for the packaging of pharmaceuticals and biologicals. With the acquisition of the Demuth Glass Works, Foster-Forbes is extending its usefulness to its container customers. It will bring to its manufacture many of the developments in the glass art resulting from the war; an important contribution in continuing the improvement in quality and service standards for container packaging fields.

COL. ROBSON BROWN OF HARTFORD-EMPIRE DIES SUDDENLY

Col. Robson D. Brown, vice-president and patent attorney for the Hartford-Empire Company, died on May 22nd of a coronary thrombosis at his home in West Hartford, Connecticut. He was sixty years of age.

Col. Brown was a graduate of George Washington University, AB 1907; and Georgetown Law School, LLB and MPL 1913. His first business experience was as an examiner with the United States Patent Office from 1910 to 1913. Thereafter he was always a patent specialist. He was in the patent department of Westinghouse Electric Company from 1913 to 1917; a member of the patent law firm of Kay, Totten & Brown in Pittsburgh from 1919 to 1924; and with Hartford-Empire from 1924.

Col. Brown went abroad as captain in World War I and saw service in the Argonne. He was retired as lieutenant colonel in the auxiliary reserve. He was a member of Hayes Velhage Post 96 West Hartford, American Legion.

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